THE

POPULAR SCIENCE MONTHLY.

SEPTEMBER, 1874.

NATURAL HISTORY OF MAN.

By A. DE QUATREFAGES.

TRANSLATED BY ELIZA A. YOUMANS.

V.—*Intellectual Characters.*

GENTLEMEN: I resume my discourse for the fifth time on the same subject. You have already, on four different occasions, studied man; and, again, man is the subject of this lecture.

On the preceding occasions I ran over some of the general questions that arise concerning the history of the human race. Depending always and exclusively upon science, I have shown that this species is unique; that all men are of the same species; and that, in consequence of this fact, they ought to regard each other as brothers, whatever the color of the skin, whatever language they speak, whatever country they inhabit.

This species at first occupied a very limited part of the globe. It spread all over the globe at an earlier epoch than was formerly believed; more recent researches have demonstrated that man existed in France along with the hyena, the elephant, the rhinoceros—that is to say, along with animals seen, in our day, only in distant countries.

As man appeared at first on a restricted point of the globe, and is found to-day everywhere, it is evident that he has traveled in all directions from his *centre of creation*, and peopled the earth by migration much as do the Europeans at the present time. These journeyings have exposed him to all the influences which can be encountered on the surface of our planet, and he has become acclimated everywhere as we see him to-day.

In the study of general questions relative to the history of our species, we had to ask what was the origin of man.

On this point I have been obliged to confess the insufficiency of actual knowledge. But, if I was not able to say whence man came, I

could say, in the name of science, whence he did not come; I could affirm that our ancestor was not an animal—neither a monkey, nor a seal, nor any other animal whatever.

At our last meeting we commenced the study of the general characters presented by the human species, and we examined its *physical characters;* that is, those which may be drawn from the body studied in a state of health and of disease. We were led also to pass in review its exterior characters, its anatomic characters, physiological and pathological. We thus obtained an idea of the general nature of man, considered exclusively from an organic point of view. Well, this study of man, in his material relations, led us to the conclusion that there is but one human species, so that it confirmed the results at which we arrived in our first lectures.

But is the body all of man? And, after studying the material being that strikes our senses, is there nothing more to study? Science will answer.

When a naturalist studies ants, he is not content with describing the thorax, the abdomen, the jaws, and the legs. He shows also how they construct their ant-hill, and to what use its chambers are destined; its galleries, where so many and such divers things are stored; he shows, further, how they raise their larvæ and their young ones; how they hold in captivity the plant-lice destined to furnish an aliment which they secrete, as do the cows and sheep we keep in our stables.

When a naturalist gives the history of bees, he does not limit himself to a description of their body and wings; he is careful to show how they build their hives, gather and knead the wax to construct the comb in which they deposit honey, the first sweet known to man. He calls the attention of the reader or listener to that unique female, always alone in each hive; he shows the respect and care that all the bee-workers have for this female, who is at once their queen and their mother.

In other words, the naturalist studies the instincts of the ants and the bees.

When he attempts the history of man, shall he put aside that which in him represents these instincts? Evidently not.

Consequently he must not stop with the body. He must consider the intelligence which is in us, and which, up to a certain point, we have in common with animals; he must show that it is this element of our being which recognizes the outer world, which judges, which aspires. His work will be very imperfect, if he neglects this something of which the nature escapes us, but of which the power is such, that through it man has not only vanquished all animals, whatever their defenses, their size, or their strength, but he has overcome and made to work, as his servants, even the immutable forces of the inanimate world, achieving all distances, thanks to the railroad! outstrip-

ping time, thanks to the telegraph! and even annihilating pain, thanks to chloroform!

Then, along with the material characters which we studied at our last lecture, we now take up intellectual characters.

It is our distinct intention, in taking up characters of a nature so new, still to remain exclusively on the ground of science.

We know the existence of faculties, and we shall point out their most general manifestations; but we shall have no concern with the nature of these faculties. In a word, we are not philosophers. Here, as in preceding lectures, we shall remain a man of science—a naturalist, and nothing else.

It will be impossible for me to examine these characters in detail. I shall neglect several, and limit myself to saying something on language, on writing, on the fundamental forms of society, on industry, and on dress.

I. *Language.*—It will not be denied that the most essential of all the manifestations of intelligence is language.

"Animals have voice, man alone has speech." This phrase is from an ancient philosophic naturalist—from the great Aristotle, who lived some four centuries before our era; it is as true to-day as it was more than two thousand years ago. In fact, man alone possesses articulate speech.

But, you all know that the manifestations of speech vary from people to people. Each of these manifestations—the languages, as we call them—constitutes one of the most essential characters of the different human groups. You all know a German, a Spaniard, an Englishman, by his language. But this is not the limit of the scientific importance of this character. Unhappily, I cannot here enter into details. I shall only attempt to show you, in a few words, how the study of language throws light on the history of human groups, even in the case of those who have lost all historic data.

You know that in France other languages than French are spoken, and that, on all sides of us, we find the Gascon in the south, the bas-Breton in Brittany, the Alsatian in Alsace, etc. Whence comes this diversity of language among a people at present so remarkably homogeneous?

History answers this question. It teaches us that, until a certain epoch, Languedoc, Alsace, Brittany, formed so many separate states, having each its own language. From this fact we are enabled to draw important consequences.

When we encounter a group actually designated by a single name, and when we find in this group secondary groups speaking diverse languages, we may almost to a certainty conclude that formerly all these secondary groups had their individual life, their political independence.

The study of language conducts us still further.

When, in place of mere juxtaposition, each remaining in the place it has occupied for an indefinite time, the different nations, from any cause whatever, come to be mixed together, they each bring their language; and, in consequence of the fusion, each brings his part of the language that becomes common. A language so formed is a mixed language, which consists of words and turns of phrases recalling the mother-languages which gave it birth.

Here, again, history shows us that this thing has actually been done. The English language, for example, has words and expressions which bring to mind the languages of all the races that have been mixed and confounded in that isle.

Consequently, when we enter for the first time a country of which we know not the history, and find a population presenting in its language words and phrases borrowed from other languages, on the right and on the left, we are authorized to conclude that this population results from the mixture of anthropological elements, which imply the linguistic elements themselves.

We may go still further.

Language, you know, changes—is transformed with time. The French language of our day is not the French of five centuries ago; the Frenchman of to-day must study specially and with dictionaries before he can read the French of the past.

So, language alters, changes, even when there has been no displacement of population. And all the more when immigration intervenes; if mixtures occur, the language will be altered, and a new language will arise. This new language may differ so much from the primitive one as to appear at first to have no resemblance to it. This may happen not only for one people and for one language, but for many. A language may also become the mother of many different languages. But these daughter languages always preserve something in common with that from which they descended; and men who have made these questions the object of continued study, the linguists, know very well how to discover the filiation. They know how to rise from derivative languages to their primitive tongues. In this way they attach together people that were thought to be very distinct because they spoke languages that at first seemed very different.

It is by this study, wholly recent, but which for some years has advanced with the stride of a giant, that we are able to unite in one source most of the people who now cover almost the whole of Europe; such as, on the one hand, the French, the Germans, the Swedes, and the Spanish; and, on the other, the people who inhabit Persia and the valley of the Ganges. These people constitute what is called the Aryan race.

More marvelous still, thanks to the comparison of languages, a philosopher of Geneva, M. Adolph Pictet, was able to trace a sort of history of the primitive Aryans, the common parents of Europeans,

Persians, and Indians. He retraced their manner of life, and, although they left no historical data, he has shown almost in detail the point of civilization at which they had arrived.

I cannot, you know, enter into details relative to this science, at once so recent and already so immense that it has been called comparative linguistic science. I can only indicate the great divisions, because, perhaps I shall, by-and-by, have to refer to them.

All the languages spoken on the surface of the earth have been divided into three fundamental groups; these are the *monosyllabic languages*, the *agglutinative languages*, and the *flexible languages*.

The monosyllabic languages are the most imperfect. Each of their words consists of one syllable. As an example, I will name the Chinese, which is a monosyllabic language, *par excellence*. In this language each word presents itself with a sense perfectly absolute, and the delicacies of our language, even the distinctions of time, of place, of going, of coming, etc., can be translated only by a kind of paraphrase.

The agglutinative tongues form the second stage of language; here there are words, placed after the fundamental conception, which serve to modify the primitive sense—roots, to employ the expression in use. As examples of agglutinative languages, I will name the negro languages, and those spoken by yellow people, and also by very small numbers of white people.

Finally, the highest development of language is that of flexible language, so named because, by simple changes in the termination of a word, we can change and modify the absolute sense, and make it express divers shades of meaning, thus: *I speak* now; *I shall speak* to-morrow. Almost all the white races speak flexible languages.

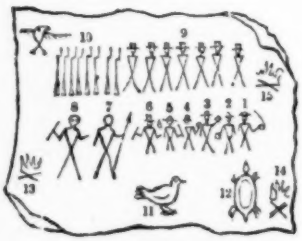
II. *Writing.*—Speech is evidently the first element in the formation of societies; writing is the most essential element of the progress of these societies. It is speech *fixed*. This alone permits the transmission of the results of our efforts to the most distant descendants—of the accumulation of the treasures that each generation has separately acquired. I should like to dwell upon its history; but I should be drawn too far, and so, for writing as for language, I can only indicate a few facts.

Almost with the lowest savages we find means to aid the memory, and serve as *souvenirs* of events to which more or less importance is attached. These are called *mnemonic* signs. They are sometimes stones, sometimes pieces of wood shaped in divers ways. A mode of appeal to the memory, found in both the Old and the New World, consists in uniting packages of strings of different colors, on which are made knots of divers forms. These are called *quippus*. You make, so to speak, a quippu every time you tie a knot in your handkerchief to enable you to recall something.

Picturing objects, men, events, in a more or less faithful manner,

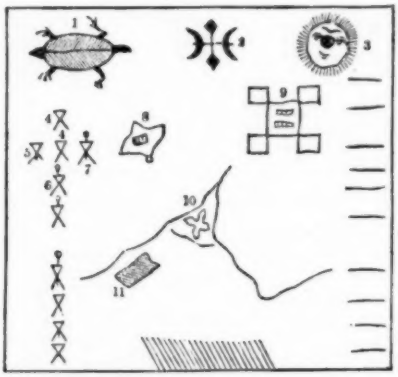
is not writing; it is what is called *pictography*. Such are those gross representations employed even to-day by the Indians of North America to transmit information (Figs. 1 and 2.)

FIG. 1.



INDIAN BARK-LETTER.

FIG. 2.



INDIAN BARK-LETTER.

EXPLANATION OF FIG. 1.—On one occasion a party of explorers, with two Indian guides, saw one morning, just as they were about to start, a pole stuck in the direction they were going, and holding at the top a piece of bark, covered with drawings, which were intended for the information of any other Indians who might pass that way. This is represented in Fig. 1. No. 1 represents the subaltern officer in command of the party. He is drawn with a sword, to denote his rank. No. 2 denotes the secretary. He is represented as holding a book, the Indians having understood him to be an attorney. No. 3 represents the geologist, appropriately indicated by a hammer. Nos. 4 and 5 are *attachés;* No. 6 the interpreter. The group of figures marked 9 represents seven infantry soldiers, each of whom, as shown in group No. 10, was armed with a musket. No. 15 denotes that they had a separate fire, and constituted a separate mess. Nos. 7 and 8 represent the two Chippewa guides. These are the only human figures drawn without the distinguishing symbol of a hat. This was the characteristic seized on by them, and generally employed by the Indians, to distinguish the *red* from the *white* race. Nos. 11 and 12 represent a prairie-hen and a green tortoise, which constituted the sum of the preceding day's chase, and were eaten at the encampment. The inclination of the pole was designed to show the course pursued; and there were three hacks in it below the scroll of bark, to indicate the estimated length of this part of the journey, computing from water to water.

EXPLANATION OF FIG. 2.—This figure gives the biography of Wingemund, a noted chief of the Delawares. No. 1 shows that it belonged to the oldest branch of the tribe, which use the tortoise on their symbol. No. 2 is his *totem*, or symbol; No. 3 is the sun, and the ten strokes represent ten war-parties in which he was engaged. Those figures on the left represent the captives which he made in each of his excursions, the men being distinguished from the women, and the captives being denoted by having heads, while a man without his head is of course a dead man. The central figures represent three forts which he attacked; No. 8, one on Lake Erie; No. 9, that of Detroit; and No. 10, Fort Pitt, at the junction of the Alleghany and the Monongahela. The sloping strokes denote the number of his followers.

When the object figured has a conventional signification, we may say that writing has begun. For example, the idea of prudence would be represented by a serpent, that of force by a lion. This manner of translating thought is symbolic, ideographic writing. It presents many stages. The hieroglyphics seen on Egyptian and Mexican monuments belong here. But all these signs do not constitute veritable writing.

In reality, this appears only when the signs employed represent the sounds of the language. After reaching this point, writing again presents two very different stages. Each syllable may have its particular character; or, better still, the elements of the syllable may be represented. This last form constitutes writing, properly speaking. It is this that we employ. The collection of signs we call an alpha-

bet; and this alphabet, which constitutes the first step of elementary instruction, is certainly one of the most marvelous inventions of the human mind. So almost all the ancients attributed to it a divine origin.

III. *Primitive Forms of Society.*—As I just said to you, it is by language that societies begin, and by writing that they make the greatest progress in civilization. But, before they attain civilization, they have long halting-places to get over, and, regarding the *ensembles* of the human races, we see three very distinct kinds of primitive society.

The lowest degree of human association is people that hunt and fish; and this inferiority is easily explained. A society composed entirely of hunters cannot be numerous, because it must live on the game it kills. Therefore, a great space is needed to nourish a sparse population. Besides, the hunter's chances are for the day; he is never sure of a living for to-morrow. This incessant uncertainty prevents him from directing his intelligence toward more elevated subjects. Hunters, besides, have incessantly to watch their hunting-grounds to prevent encroachments. In other words, the hunter is the image of war. Wars easily arise between neighboring populations placed in identical conditions. These wars are without mercy, for each prisoner is one more mouth to feed; kill him, then. Hence, hunting-tribes are almost inevitably courageous, sometimes heroic, but warlike and cruel.

As soon as man domesticates certain animals—cattle, sheep, or llamas—as soon as he becomes pastoral, his to-morrow is assured. He can at once begin to occupy himself with something besides his food; and we see societies of this kind begin to make progress. However, pastoral people need vast spaces for their animals; these promptly exhaust the herbage of a canton; it becomes needful to go elsewhere after food for the animals which supply milk and flesh, the nourishment of the master, and so a pastoral population cannot exist in great numbers. They easily become nomadic. In their migrations the hordes meet and dispute by force of arms for the precious pasturage. War breaks them up; but prisoners may be utilized by the conqueror, and their food will not be a great sacrifice. They are spared, and slavery is born.

Society takes its third form, when man finds that the vegetable kingdom furnishes more abundant and reliable food than that obtained from animals—when he becomes an agriculturist. Besides, agriculture gives him leisure. His manners soften. War, when it breaks out, becomes less cruel. Prisoners employed to work in the field can render services more and more considerable. Slavery becomes serfdom. Relieved from imperious material necessities, the intelligence of the master awakens and enlarges. A true civilization may arise and grow among agriculturists.

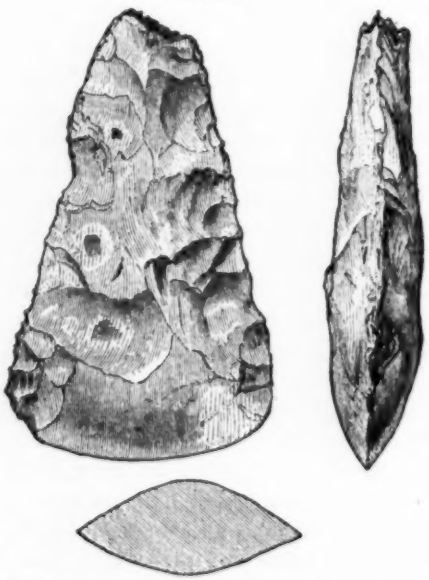
Centuries ago Europeans attained a social state permitting the de-

gree of civilization of which we are so proud, and this leads me to make an observation.

Too often, under the influence of our actual superiority, we disdain the people who are behind, whether in the pastoral state or in the state of hunters. We proclaim them incapable of reaching our level.

This opinion is nowhere justified. Forget not that we have passed by the same halting-places. Forget not, above all, that many civilizations have preceded our own. Two thousand years before our era the Chinese raised monuments that still excite the admiration of travelers, cultivated the mulberry, raised the silk-worm, and possessed notions of astronomy. Egyptian civilization is still more ancient. You saw proof of this at the Universal Exposition. In the temple raised under the direction of N. Mariette you must have admired, among other things, that magnificent statue of Chefren placed at the bottom of the hall, and which dates 4,000 years before our era. At this time we were true savages, covered with the skins of beasts, and carrying on our persons, under the pretext of embellishing ourselves, paints and tattooing like those of the most backward races of our own day. The effect of this should be, on the one hand, to awaken our modesty, and on the other to render us indulgent to people who are yet at the point which we have escaped.

FIG. 3.



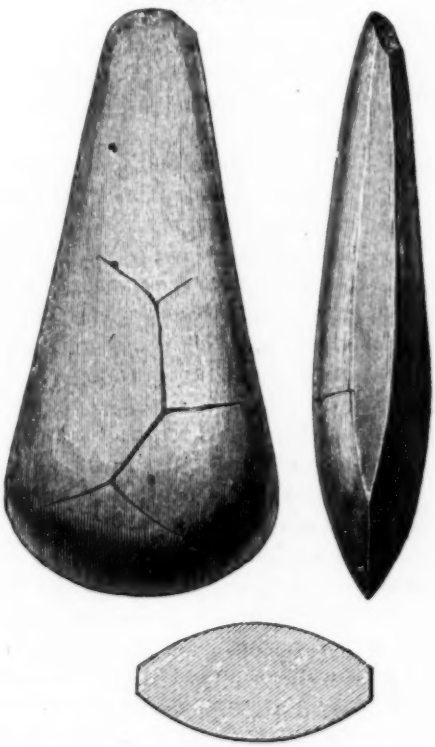
IV. *Industries.*—It is in the midst of primitive societies that industries are born and flourish. However low a people may be, it always has its own proper industries. Man is essentially an industrious being.

All industries suppose utensils; and the matter of which these utensils are made furnishes the means of determining to a certain extent the degree of civilization attained by people whom we know only by traces they have left.

In the beginning we see stone alone used to fabricate utensils and weapons; for these two things proceed together. Everywhere, man is at first content to shape more or less perfectly matter furnished him by the soil. Look at these samples of stones (Fig. 3) which have served as hatchets, whether for domestic use or war. You see they are fashioned very simply. These objects came from our soil; they served our first ancestors and attest the truth I have just stated.

In proportion as man progresses, he is not content simply to shape the stone; he polishes it. His first attempts in this way are coarse enough. At first the edge of the hatchet alone is polished. Later the entire hatchet, and sometimes in a remarkable manner (Fig. 4).

FIG. 4.



The hatchets as well as the knives are generally of silex, that is, of that species of stone which formerly served as flint in striking fire. Its hardness explains why it was chosen for these purposes. When it

began to fail they could employ others. Finally they fell back on shells, and it is impossible not to admire some of their works executed with such imperfect instruments, with fragments of stone less hard than our silex, and the *débris* of marine shells. After stone, appeared the metals; but not iron, of which we know so well the uses and which alone has made possible the miracles of our modern industry. Copper and bronze preceded iron; in America copper, in our Europe bronze, came after stone.

Fig. 5.

Boomerang.

Finally, iron made its appearance, and many evidences prove that from its first discovery its value was understood. In the gymnastic plays celebrated by Achilles on the tomb of his friend Patroclus, at the epoch of the Trojan War, twelve centuries before our era, a mass of iron is proposed as a prize, and Achilles himself speaks of its importance.

The diversity of material employed in utensils marks the true stages in the history of ancient peoples. At this time we generally admit as distinct periods the age of stone, the age of bronze, the age of iron. The age of stone is divided into two periods, according as the utensils and weapons were polished or only shaped. It is to this most ancient period that the population belonged which lived in Europe with the elephant and rhinoceros.

I must refer you to the special history of the several races for further details of their industries. But I will add a few facts to the preceding. Let us speak a word about the warlike industries.

Wherever human society exists, we find instruments of war. After the need of food, it seems the most pressing want of man is to kill or enslave his kind. We may say that man is a warlike being.

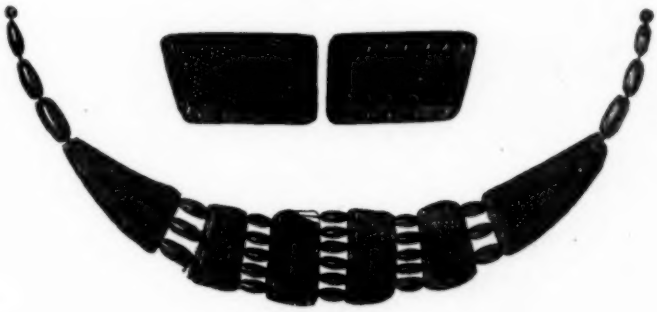
Among the lowest people of the globe we find offensive and defensive arms; and everywhere those at the bottom of the scale astonish us by the ingenuity of these arms. The Australians, certainly a most inferior people, use a not very large but very thick shield. Their skill in parrying strokes is most remarkable, as all travelers admit. The same people use curious weapons; one, called the *boomerang* (Fig. 5), is a bit of hard wood, very flat, sharp, and more or less curved. The inhabitants know how to throw this little piece of wood so that, after it has struck the enemy or the game, it rises in the air, turns, and falls into the hand of the thrower. The boomerang realizes, then, the en-

chanted arms spoken of in the old fables—arms which, after having struck the mark, come back themselves to their possessor.

V. *Dress.*—If I point out some facts relative to dress, it is to show you how much of connection, of real resemblance, there is between the most savage and the most civilized people.

Everywhere and always man has sought to embellish himself. Sometimes by acting on himself, sometimes by borrowing the elements of his dress from without. In the tombs discovered from time to time which inclose the remains of men with their stone hatchets, used in France against the elephant and rhinoceros, in those tombs, I say, we find collars (Fig. 6) made of morsels of shells or small corals

FIG. 6.



NECKLACE.

which had not, in the eyes of their possessors, a less value than the precious stones have for us. We might almost define man as a being who ornaments himself; and certainly here is a great difference separating him from the animals. I shall not dwell on the different materials taken from the exterior world to cover our bodies and embellish us. Were you to see a woman of Tahiti in grand costume, you would remark that when our grandmothers had contrived the panniers, and the women of our day the crinoline, they only borrowed from the children of the South Sea a part of their attire.

It is worthy of attention that, under the pretext of embellishing himself, man has almost always sought to modify his own body. So the Chinese women, in order to make their feet very small, cripple themselves in so grave a manner that often the little children succumb in the operation. The bones of the heel, in place of elongating behind, are violently displaced and directed downward, so that the women walk on their own heels as on the heels of their shoes. The toes are likewise turned under, the big toe alone being in place. Our women do not go so far; but you know women who, to make the feet small, fear not to give themselves corns, and many men do the same.

At the Philippines, the group of isles that you see at the east of Asia, is a people whose women attach great importance to having the

largest possible fist. To make it large, they swaddle the arms, which consequently remain slender, while the fist enlarges in a fashion very repulsive to our European eyes.

But the head seems to have been, by preference, the object of these strange caprices, probably because it is the part of the body most evident and most important. Some people seek to change completely the form of the cranium. For this purpose they place on the heads of children, immediately after birth, contrivances which project them forward or backward, and then, by pressing tightly behind and before, the head is made flat. There is a people on the western side of America which surrounds the head of the infant with a bandage so as to give it the form of a sugar-loaf.

I must remind you that among ourselves the ears are still pierced to suspend ornaments from them. If men have generally renounced this fashion, women remain very faithful to it. But all the other parts of the visage have been submitted to the same mutilations, the nose, the lips, the cheeks themselves have been pierced, always to suspend or introduce into the openings some morsel of wood, of stone, of bone, as ornament.

FIG. 7.

HEAD OF NEW-ZEALANDER.

FIG. 8.

HEAD OF NEW-ZEALANDER.

The face and the forehead are frequently decorated with divers tattooings (Figs. 7 and 8), made sometimes by pricking, sometimes by cutting the skin. At the Marquesas Isles, not only the countenance, but the entire body, is tattooed. You see here a warrior (Fig. 9) of that country, and perhaps you think him covered with a motley costume; no, it is simply tattooing.

Jest not too much at these ornaments of savages. Our ancestors wore the same, and the fashion is not wholly effaced with us. More

than one of you, doubtless, has on the arm or on the breast some red or blue figure representing a heart pierced, two swords crossed, an anchor, or a hammer, symbols of your profession.

Along with these tattooings incrusted in the skin by various processes, we may place also the paintings. Here, again, is a means of embellishing that every people has practiced and practices still. Some-

Fig. 9.

Caroline Islander.

times these paintings have precise significations; there are the paintings of war, the paintings of peace, the paintings of *fêtes*, etc. We do not go so far; but we must not forget that the most civilized Europeans have painted and still paint the countenance. Our grandmothers habitually used white, and, above all, red; they put on patches, that is to say, small rounds of court-plaster to give beauty to the skin by contrast. And to-day, you know, our fashionable women tint themselves so well that a word has been invented on this subject. So

we find, in our most elevated classes, that which seems so strange in savages.

The head of hair offers the same considerations. With savages as with us, it is an object of no less special care. Negroes, Hottentots, Polynesians, etc., stiffen their hair with grease, and color it with pow-

FIG. 10.

FIJIAN MODES OF DRESSING THE HAIR.

ders, red, yellow, white, etc. (Fig. 10.) Everywhere they decorate it with flowers, feathers of all sorts, brilliant crystals, grains of glass. Well, our fathers pomaded and powdered themselves; our women pomade themselves, and put flowers, feathers, and diamonds, in their

hair, which are, after all, only crystals, more or less dear. And as to our pomades, whatever name we give them, they always have, for foundation, the oil of almonds, or the fat of pork. You see that, between the article used by savages and that we make ourselves, there is no great difference.

III. *Moral and Religious Characters.*—We pass to another order of characters. By his body, I repeat, man is an animal, nothing more, nothing less; by his intelligence he is infinitely superior to animals. But, to judge by fundamental phenomena, the nature of our intelligence does not differ from that which they manifest.

Are we, then, only a more intelligent kind of animal? I have already answered this question. No; we are not animals, we are something else; for, besides the phenomena which we have in common with them, we have our special character, connected with faculties, of which we find not the least trace in the most elevated animals. These faculties are *morality* and *religion.*

I. *Morality.*—Among all people, in all races, there are expressions which mean good and bad, honest man and scoundrel; consequently, all men have the abstract notion of good and evil.

Objections have been made to this idea that morality was an attribute of man; or, rather, difficulties have been raised on the subject. Some say, for example, that animals know also what is good and what is bad. This is true for our most perfect domestic animals, as the dog. Thanks to our superior intelligence, we have accustomed them to that which is good and bad *for us.* But leave them in a savage state, and you will never find them doing any thing to which you can attach the notion here implied. Man is certainly the only being that we see war against pain—physical evil—that he may reach moral good.

It has been said again that morals differ from people to people, and the attempt has been made to draw from this an inference that morality is not characteristic of man. The faculty itself is here confounded with its manifestations. We forget that the same sentiment can be expressed by very different and sometimes opposite acts. I will take, for example, those which testify to politeness and the respect we pay to superiors. In the same case, the European rises and uncovers his head; the Turk, on the contrary, remains with the head covered, and the Polynesian sits. These contrary acts are not less, the one than the other, acts of deference.

We must place ourselves at this point of view to judge of morality. We must, in such cases, and, above all, when it is a question of inferior peoples, forget our own notions on this subject, and seek after the general ideas of the people we are studying. We must recur to what has taken place with us at certain epochs, and then we shall find that there is not as much difference as we imagined between the most civilized and the most savage people. We shall return to the subject in treating the history of races. To-day I can only say a few words rela-

tive to three chief principles: *Respect for property, respect for the life of others, and respect for one's self.*

I. *Respect for Property.*—It has been said that the notion of property does not exist among savage people. This is an error. With them, arms, utensils, instruments, are strictly personal property, as with us; but some travelers have been deceived by the existence, among hunting-tribes, of another kind of property, communal property, if I may so speak. Among these people the ground does not belong to the individual but to the entire tribe. Under this relation the property is so well known that war is the consequence of the least violation of the hunting limits.

Certain races have been accused of being essentially thievish. This reproach is brought particularly upon the negroes of the Gulf of Guinea, and upon the Polynesians. They have been accused of stealing even the nails of the ship. But let me remind you what iron is for people who do not have it. It is more precious to them than gold. Well, suppose there should arrive among us a ship, gold clad and nailed with diamonds and rubies. Do you believe it would go out intact from our ports? Remark further, that, among the negroes of Guinea and Polynesia, those who steal of their comrade are dishonored and punished as they would be with us. They have the idea of respect for property the same as ourselves.

II. *Respect for Life.*—Everywhere the life of man is sacred; everywhere the murderer is punished; but, with ourselves, circumstances determine the nature of the act. Nobody would treat as an assassin him who beats fairly in a duel; the soldier who has killed with his hand a great number of enemies is decorated; very far from being punished, he is recompensed. With savages the formula is still more elastic. For him the stranger is always an enemy; besides, vengeance is in his eyes a virtue, and when he has a murder to avenge he cares little to strike the murderer himself. Provided he furnishes a member of his family or his tribe, his vengeance is satisfied; whence results the *bad blood* between European travelers and the Polynesians in particular. These people have too often complained of violence exercised by Europeans, who have left without being punished. The savage watches for those who come after the really guilty, sets a trap for them, and massacres the innocents. He applies his moral law, and we find the theory horrible. But forget not our middle age; we have got the start a little, but, in our day, if the *vendetta* were not abolished in Corsica, it would be the same, as it was the same in Scotland between clan and clan.

For the rest, gentlemen, the question of respect for the life of others is one of those that I least like to enter upon, because I cannot speak without blushing for the white race. You know that it rules everywhere, but some of you do not know, perhaps, that everywhere devastation and massacre have marked its steps round the world. It seems

that it has used its superiority to annihilate its sister races, and reign on their tombs.

III. *Respect for Self.*—I have shown you that the evils of which we accuse the savages exist with us. Permit me to show you among them the good of which civilized people pretend to have the monopoly. The sentiments of honor and of modesty are certainly two of the most noble and most delicate of the respect due to one's self. We find these two sentiments developed sometimes in a high degree in the most savage peoples.

It is evident that the idea of modesty must vary from one region to another; it cannot be the same among people forced by the climate to go naked, and among those who are compelled, by the rigors of climate, to wear clothes. We ought, in this respect, to look for marked differences, and to take account of these exigencies; besides, from the nature of the subject, I cannot enter into details, and I will only say that more than one traveler has expressed his astonishment to find more of true modesty among naked savages than among civilized and well-clothed people.

Honor is, perhaps, the sentiment which is most uniformly manifested among these people. To obey the sense of honor, they hesitate not to provoke torments, to brave, and even to solicit, death. A young Kaffre chief is condemned to death; he may be pardoned on the condition of losing his ostrich-feather, which for him represents epaulets; he demands, as a favor, to be thrown to the crocodiles rather than be dishonored. The red-skin made a prisoner, attached to the post of torture, defies his enemies to extract from him the least sign of suffering.

That which we call chivalric generosity exists among the most savage peoples. Two Irishmen quarreled one day with some Australians; they were without arms. Instead of profiting by this advantage, the savages gave them arms, that they might defend themselves.

In our war at Tahiti, Admiral Bruet, commander of the French forces, took a bath one day in a river of the interior of the isle, while a well-armed chief belonging to the enemy was concealed near by. When peace was gained, this chief came to see the admiral, and easily showed him that for nearly two hours his life had been in his power. "Why did you not draw?" said the admiral. "I should have been dishonored in the eyes of my people," replied the native, "if I had killed by surprise a chief such as thou."

See how the people called savages often conduct themselves. Would we do better?

You see, gentlemen, and you may fearlessly say, to the honor of our species, that morality, in its more serious as well as in its more delicate aspects, is found among all men; and, decisively, man is a moral being.

II. *Religion.*—I come now to another order of considerations, that

it will perhaps surprise you to hear me discuss. I have said, at different times, that I wished to be a man of science, that I did not wish to enter here upon either philosophy or theology, and yet I am going to speak of religion. I shall continue faithful to my programme. It is as a naturalist that I shall take up the subject. As for morality, I showed the existence of the faculty; then I pointed out some general facts, reserving the special facts for the history of races. To-day, as heretofore, I shall avoid with care the dogmatic and the theologic side of the discussion.

The first fact to establish is the universality of the manifestations which belong to religion. In every country, with all peoples, in all races, we find the belief in beings superior to man, and influencing his destiny for good or evil. Everywhere we find the belief in another life succeeding to the actual life. These two notions lie at the foundation of all religions, and whoever admits them is religious. We can say, then, of man generally, that he is certainly religious.

Objections have been made to the generality of this character. Let us rapidly examine the case.

Some authors affirm that there exist atheistic people. They have cited in proof the Australians of whom I have already spoken, and the Bushmen. These are mistaken assertions; but this error may be explained. Three causes, acting together or separately, have contributed to a misunderstanding of the religious beliefs of the inferior races of humanity.

The first is the beliefs of travelers. When these travelers are missionaries, having an ardent faith but a narrow intelligence, they are easily led not to accept, as true, religious beliefs so different from their own. Often, in their eyes, these beliefs are a work of the devil; they put them aside, or do not take the trouble to discover them, and they offer us, as atheistic, people who certainly are not.

Ignorance of the language often leads to regarding a people as atheistic. A traveler encounters a savage tribe; he puts questions, well or ill, often by signs alone, on the Deity, or on the soul; the natives do not understand, and reply by some gesture of negation, and the traveler concludes that they believe neither in God nor immortality.

But, the great cause which has often led to the conclusion I am opposing, is the disdain of Europeans for savages. Generally, the European, proud of his knowledge, and overrating his superiority, judges in advance their incapacity to attain to notions a little elevated. He takes no great pains to discover what he believes does not exist. At the first failure he thinks himself right in concluding that these inferior races are incapable of attaining to the notion of God and of a future life.

Happily there are some tolerant missionaries who have studied them more closely, and laymen who have been able to see brothers in

these inferior representatives of the human family. Thanks to the intelligence of these patient, clear-headed men, we now know that these Australians, that were said to have no idea of God, have in reality a rudimentary mythology, which sometimes recalls our own European superstitions. We now know that the Bushmen deify their great men, and address prayers to them. As to the Bushmen, they have a remarkable idea of the Divinity. They regard him as a great chief, who resides in heaven. They say of him: "We see him not with the eyes; we feel him in the heart."

This last phrase, which I quote literally, was obtained by travelers who lived in the midst of these people. They show that sometimes the people justly placed in the lowest rank of the human races may have, along with the strangest superstitions, religious notions remarkably elevated. This fact is often presented when we examine the religion of different peoples. We find, it is true, much that is *bizarré*, many strange and shocking things, but we find also behind these absurdities ideas and beliefs which astonish us by their seriousness, by their elevation, by the resemblance they offer to that which is believed by more advanced people.

The negroes of Guinea may serve to illustrate this subject. All travelers have spoken of their absurd beliefs, all have spoken of their fetishes. They tell us how these people prostrate themselves before serpents, trees, bits of wood, bone, etc., carefully wrapped up, and on which their priests have performed certain ceremonies. There are few who would seek that which might be found at the bottom of all this. Those who have made the search have found religious ideas, very superior to these appearances; the belief in divinities of different orders, living in the skies, and presided over by a sovereign creator who made every thing. When we look still further, as M. d'Avezac has done, we find prayers conceived in terms such as a European, a Christian, might repeat without blushing. In the case of these negroes, as in our own, we must distinguish between religion and superstition, two extremely different things, which are too often confounded. I will add but a few words.

Gentlemen, I close to-day the first part of the lectures that I have undertaken to give you. Let me formulate the last conclusions.

We have asked only general questions, those which bear on the entire human race, and which may consequently conduct us to the foundation of the nature of man. We have asked them exclusively from the point of view of natural science; we have studied man as we study an animal or a plant. The result of this examination is to show in man a *résumé* of the entire creation.

In him we find phenomena exactly parallel to those encountered in minerals, in plants; consequently, all the forces acting in minerals and plants we find in man.

By his body, from an anatomical and physical point of view, man

is an animal, nothing more, nothing less; hence all the animal forces act in him.

But is it by his body that man has acquired that empire that we have seen he possesses? You know very well it is not; you know very well that, if he reigns over all around him, over inanimate Nature as over organized Nature, he owes it to his intelligence, of like nature, but immensely superior to that of animals.

Finally, man has his own attributes—faculties that belong exclusively to him—morality and religion. Well, these exclusively human faculties seem admirably to complete this exceptional being. It is these that ennoble him, and justify the incontestable empire that he claims over the globe; for it is these which, along with the sentiment of punishment, give birth to the idea of duty, the thought of responsibility.

Here, gentlemen, is the summing up that one is led to make of man when he is studied exclusively from knowledge by the naturalist. I hope you will find that you have lost nothing.

THE PHOTOSPHERE AND SUN-SPOTS.

By Prof. S. P. LANGLEY,
DIRECTOR OF THE ALLEGHANY OBSERVATORY.

WHY is it that almost any one who was offered the opportunity of witnessing an eruption of Etna, or the effects of a tropical cyclone, would embrace such an occasion with eagerness, while phenomena so similar in kind, and on so far grander a scale, visible daily on the surface of the sun, excite a comparatively feeble interest in all but those devoted to their study?

It is doubtless, in part, because we have a more intimate and awe-inspired interest in disturbances which happen so near us, and which we do not extend to others with which we conceive we have less personal concern; but the difference of the kind, as well as the degree of our interest in solar phenomena, from that which we take in those which occur, as it were, at home, is due in part perhaps to a remoter cause, and forms a portion of the unconscious bias which the modern mind has inherited from ancient modes of thought.

Deeply impressed by the fact that the sun had warmed and lighted the world from unknown time, with a fire which never seemed to be fed, yet which never burned low like a terrestrial flame, ancient philosophy concluded that the sun was formed of something quite other than any gross earthly elements—of an element of pure fire, which shone and warmed forever without fuel, because it was its "nature" to; just as it is the "nature" of a fire on the hearth to burn only

when fuel is supplied to it. The sun was, then, to the ancient world, a kind of supernatural phenomenon, interest in which partook more of the uninquiring awe due to an immediate miracle of Deity, than of the curiosity excited by a fact of the natural world; and whatever we may think of such a way of regarding the matter, the view of the ancient philosophy, that the sun was an immaculate orb of pure fire, self-sustained, continued to be accepted almost as a dogma of the faith down to times subsequent to the dawn of the modern philosophy.

When one of the first, possibly the first, of the observers of sun-spots, Christopher Scheiner, a Jesuit, communicated his discovery to his provincial, the latter, Mr. Proctor relates, answered: "I have read Aristotle's writings from beginning to end, many times, and I can assure you I have nowhere found in them any thing similar to what you mention; go, therefore, my son, tranquillize yourself, be assured that what you take for spots in the sun are the faults of your glasses or your eyes."

Perhaps we are, however unconsciously, ourselves in some degree Aristotelians in such matters, and it is at least certain that the unrecognized influence of ancient modes of thought has delayed progress in solar physics, by preparing astronomers to admit theories which they could not have accepted with a clear recognition of the fact that physical laws are the same in the sun as here, however erroneously we learn them from our limited terrestrial experience. In the hypothesis of Wilson, for instance, that exhaustless flow of solar light and heat is made to come from a shallow stratum of brilliant cloud, surrounding a dark and presumably cold and solid globe. The elder Herschel adopts this hypothesis, with slight modification (it is not yet quite dislodged from the text-books), and even his eminent son appears to feel nothing like an imperious demand for a sustaining cause of the almost infinite flood of heat his own researches showed that these clouds must be giving.

It seems *now* extraordinary that men justly eminent as the Herschels could rest satisfied with an hypothesis which so evaded the consideration of the fundamental problem of the equality of the solar radiation, by tacitly assuming the suspension there of the most familiar laws of terrestrial experience.

The views now generally accepted contemplate the sun as hot throughout its mass, and in such a mass as containing indubitably an enormous though finite reservoir of heat. And, if, so far at least, there is an agreement even among those who differ as to the way in which this heat originated and is maintained, much is due to astronomers like Faye, who have insisted on this recognition of the need of accounting for the equable emission of heat with a success which may make us underrate our obligations to them, as this need, once enunciated, is so clear as to seem a truism, though it was far from being such till a very recent period.

We must, then, look at the sun with no more idea of witnessing any thing without the sphere of natural laws, than in looking at a fire across the street. It need not follow that we shall find the operation of those laws exactly the same that our limited experience has presented, and we shall still find abundant cause for admiration and wonder without introducing mysteries of our own creation.

When we telescopically examine that brilliant surface which we see daily with the naked eye (the photosphere), to study such of its phenomena as are here described, we do not need the spectroscope, but some means of protecting the eye from the blinding light and heat, and this should not involve the use of any colored shades. If we look into an unsilvered glass, as, for instance, into the panes of a shop-window from the street, we observe that it acts as a mirror, sending back a feeble reflection of ourselves, or other objects without; most of the rays from which have gone altogether through the glass, while a comparative few are returned to form the image. It may occur to us, then, instead of looking directly at the solar image formed by our telescope, to let it fall on a piece of plain glass, placed diagonally, through which about nineteen parts in twenty of the light will pass and be thrown away, the remaining twentieth being reflected and forming an exact though enfeebled image.

When this has been done, if the reflected image be still too bright, we may reflect it again, this time only a twentieth of the first twentieth reaching the eye, and so on to any degree; but it is strikingly illustrative of the intensity of the solar splendor that, when, by three such reflections, the sunlight has been enfeebled 8,000 times, we yet find it intolerably bright. Instead of more mirrors, it is better to now arrange that the third mirror may rotate, so as to *polarize* the light. When this is done, the image of the sun appears distinct (if the optician have done his work well), colorless, and of any brightness desired.

The instrument just described in general terms is known as the polarizing eye-piece. All danger and discomfort in studying the sun disappear with its use, and we may look at its unclouded face as though the eye had been strengthened to bear its light; in fact, many hours of scrutiny of the solar disk with this instrument wearies the eye less than a few minutes' telescopic examination of the moon does without it.

What we shall see with it is far from being that sphere of dazzling light, everywhere equally brilliant, which we have been accustomed to consider the sun. The eye ranges over a vast surface, presenting at one view over five thousand times the entire area of our globe, to find everywhere diversity of shade. It is not only darker near the edges than at the centre, but the whole (apart from any consideration of the spots) presents an appearance somewhat like that very peculiar one which the ocean has when we obtain a bird's-eye view of it from some great height.

Any one, for instance, who has looked down upon the Mediterranean from the summit of Gibraltar or Capri, and can recall its curious unlikeness to its familiar aspect—its apparent stillness, the faint intricate bands of white and gray, which, thus seen, overlap it like a net-work of broad veins, and the strangely permanent patterns left by the foam, which are entirely lost to us as we approach its tossing surface—will have a not wholly inadequate idea of the first impression made by the sight of the photosphere. If we bring ourselves nearer, as it were, by an increase of magnifying power, we lose sight of the larger masses of light and shade, whose place is filled by a curious mottling of faint, inextricably confused, and intermingled moss-like patterns.

With the best optical aid, and in those rarer moments when our own atmosphere is comparatively tranquil, we discern that the whole of these cloud-like mottlings are composed of very minute definite oval forms, which have been compared to grains of rice.

Minute as they appear, their real size is very great; for, though in a large telescope they seem mere dots, the average area of each is certainly much over 100,000 square miles. Since we see them at all, it must be owing to some inequality of brightness which distinguishes them, and, in fact, they do not seem to be in absolute contact, but present rather the appearance of numberless little white clouds, arranged with a sort of order upon a background of darker sky, or, if we compare them to rice-grains, we may suppose the grains arranged in rude tesselated patterns upon a gray cloth.

The most extraordinary conjectures have been hazarded as to the real nature of these objects, which are of somewhat recent discovery, and which are so difficult of observation that few have distinctly seen them. Whatever these things may be, they are the principal source of the sun's light, and presumably of its heat, and this adds to the interest of their study.

The writer has given a considerable time to their observation, which can only be carried on successfully by patient waiting, and the employment of those scattered moments when the ever-perturbed atmosphere of the earth is relatively still. He has been led to conclude that these bodies are composed of still smaller forms, and that their total area is inconsiderable compared with that of the whole sun, for, though it is almost impossible to determine the aggregate space occupied by such minute things, the writer has been led to conclude that it can hardly exceed one-fifth of the solar surface, and may be much less. An inconsiderable part only of the solar light comes from the relatively dark background on which they appear, and, in reference to these still mysterious things, we may, then, partly adopt an expression which Huyghens used with regard to the faculæ, and say that there is indeed in the sun "*something brighter than the sun itself.*" The expression will not appear a forced or exaggerated one if we reflect

that (if we rely on the correctness of the observations just alluded to) the average brilliancy of each of these bodies cannot be much less than *five times* that of full sunlight, "sunlight" itself being, in fact, caused by a dilution of their brilliance with that of the gray background which has been just compared to the cloth on which white grains are grouped.

There are inequalities in the brightness of these bodies, some of which fall below, while others as certainly exceed, the average. If we remember that each of them occupies an area larger than Great Britain, that this area is, throughout, *brighter than the sun* (in fact, not in metaphor), and that such enormous bodies, whatever they may be, exist in the sun in numbers which are almost incalculable, we reach up to some idea, but doubtless an inadequate one, of the incomprehensible vastness of the solar sphere, and of the interest of the problems it offers for our study.

In order to examine these bodies under other conditions, we must look at a sun-spot. Here, again, we find it difficult to conceive the vastness of the field of operations, for, including both branches, the "spot" represented in our engraving covers over 1,000,000,000 square miles. If we fail utterly to "realize" the extent this represents, we may, perhaps, derive aid from its comparison with some familiar terrestrial object. In the small circle, accordingly, the continents of North and South America have been drawn on the same scale as the spot, as they would appear; that is, if they were actually transported to the solar surface, placed beside the spot, and viewed, together with it, from the distance at which the earth is from the sun.

The engraving is from a drawing by the writer. This drawing, while representing the general outline of a particular spot, seen in March, 1873, embodies the result of many previous studies on similar ones, and it has been made much less with an attempt to gain pictorial effect than to truthfully present such features as will help to give some idea of the constitution of the solar surface.

We see that each branch of the spot consists of two main parts, an outer (the *penumbra*) and an inner (the *umbra*), and beyond this rude division little seems to have been observed till recent years. The knowledge of the real complexity of spot-structure and the fullness of detail needed to represent it are of such recent origin that Sir John Herschel, who, in the Cape-of-Good-Hope observations, has given a number of sun-spot drawings, points out, in one of them, the tendency to a radial structure, as something remarkable and nearly unnoticed; and the fact that so eminent an observer should have made the spots his careful study without detecting more of the structure since discovered, will illustrate the difficulties attendant on such an investigation. If we look at this, not merely as at a picture, but in the way in which we should examine a geological map, with the purpose, that is,

THE PHOTOSPHERE AND SUN-SPOTS

of studying the superficial details as indices of the real nature of the structure, we are naturally led to inquire whether the surface before us is a solid like one of our continents, or a fluid like our seas, or a vapor like our clouds. We know, at the outset, from abundant evidence, that the temperature of the sun, whatever it may be, is far

above that at which the materials chiefly composing the earth's crust would become fluid. It is, then, at the outset, an unlikely supposition that the surface of the sun should be solid; but, independently of such considerations, the behavior of this, or any other spot, is decisive as against this alternative. It was formed and grew to its present size in a comparatively short time, and, according to past experience, it will shortly break up and disappear.

Besides its rotation *with* the sun, the spot has an absolute motion *on* it, advancing, as a whole, at a greater angular velocity round the solar axis than spots nearer its poles, besides having a slight oscillating movement, which carries it alternately nearer to and farther from the sun's equator; all this going on simultaneously with changes in its form and size. The spot then moves about on the sun as a ship on the ocean, or, to employ a less inaccurate simile, like a rent in the clouds of our sky, which, while turning with the earth, both shifts its place and alters its appearance from hour to hour, the spot not being something above the sun's surface, but a gap in and below it. We seem irresistibly led to the conclusion, then, that the surface of the sun is not a solid, and, considering this freedom of motion, we are led to question if it can even be a liquid, and whether we must not look upon it as wholly vapor-like.

But we may approach the spot and look within it for answers to these questions, though, as we do so, the reader should distinguish between the facts stated and the inferences drawn from them. As to the former, observers may be said to agree with little exception; as to the latter, astronomers are, in some cases, at variance, and what follows is chiefly confined to a statement of fact, since a review of opposing hypotheses would not be at present in place.

The approach to the spot is scarcely marked in the engraving by any variation of the surface; though there is, in reality, a very slight blurring of the luminous masses (rice-grains) which makes these look less distinct as we draw near the edge. Here, all at once, the appearance changes. We are approaching what is really the outer rim of an enormous shallow funnel (that shown is 20,000 miles across); shallow, that is, in the outer portion only which is saucer-shaped, while the spout of the funnel is indefinitely deep. The first or gentle slope is the penumbra. It does not shade off into the photosphere, but begins, as has just been said, abruptly; and this sudden transition is a thing to be noted. We also observe that the edge is extremely irregular—full of indentations and subdivisions, patches of the photosphere pushing out here and there over it, and at times apparently hanging suspended above the abyss.

The sides of the slope are filled with what seem at first sight like long white threads, radially disposed, so that a circular penumbra, looked at casually, has somewhat the appearance of the iris surrounding the pupil. A closer look shows that these threads are not ar-

ranged exactly radially (in some spots not at all so). They are often contorted and thrown over each other, and evince a tendency to curl into sickle-shaped curves as they approach their inner extremities; while, if we examine them at the penumbral circumference, we find them to be apparent prolongations of those minute white objects to which the light of the sun has just been referred.

These "threads" or "filaments" are difficult of observation, for their average thickness is probably not over 200 miles, a width quite invisible at the sun's distance, in any thing but a very good telescope. Some appearances make it probable, however, that they are composed of filaments still finer, just as the finest silk thread is made up of numerous fibres, and they have a certain disposition to unite in fascicles, which are often mistaken for them. The dimension of 200 miles, then, is somewhat an arbitrary one, marking perhaps rather the present limit of vision of our telescopes than any real limit of the actual size; but, however this may be, the extraordinary length of these filaments is not open to question; they are quite commonly met with three or four thousand miles long, and the writer has occasionally distinctly traced one of these attenuated forms uninterruptedly through a much greater distance. What they are is still unknown.

What are the forces which cause the spot to move as a whole upon the solar surface, and what are the nature and direction of those which modify its form, and so completely change in a few days, or even hours, the disposition of its parts over its so vast area? To the first question there is, as yet, no satisfactory answer, though our knowledge, such as it is, seems to point to a constant interchange of matter between the surface of the sun and its interior, far within which seem to be impressed on the ascending currents velocities of rotation which so modify those which obtain at the surface. As to the second, the spectroscope, if appealed to, offers but very partial help, and we here restrict ourselves to a description of methods which do not involve its use. How may we determine the *directions* of the currents which we cannot doubt exist within the spot?

It has happened to the writer to be lost in one of the shallow, labyrinthine lakes, in the interior of our Northern wilderness, on whose still waters the canoe was left to drift aimlessly with the wind, while the guide sought, at first vainly, the traces of some current which would indicate the direction of the outlet; till, looking below the surface, the common direction of the extremities of the water-grasses, rooted at the bottom, showed the existence and direction of a current otherwise unperceived, and gave the question its solution.

The long filaments of the penumbra may be used in a similar way, flexible as they are, and rooted, as it were, at one end, while the other sways in the currents of the solar atmosphere, yielding to it as freely as the grasses to the water, or a streamer to the air; and the analogy is noteworthy in this: that one end of the filament is commonly made

fast, while the other is left free. This is so very generally the case that we see that, if these filaments be clouds, they differ from ours in other circumstances than their shape. Those we are studying are bent into curves, which show that the solar winds frequently move in circular sweeps, and are, to a considerable degree, comparable with our cyclones. Long, twisted ropes are sometimes formed by them, one being thrown over another; and, in cloud-like masses, they at times move over and conceal lower portions of the penumbra—the abrupt changes in the directions of motion showing us that these are superposed strata of what, for want of a better word, we must call solar clouds, which drift across each other's course occasionally, nearly at right angles, while the ever-moving whirlwinds leave an unmistakable record of their action on these pliant forms.

In one part of the spot, one of these has been bent into a complete loop, or closed curve, the extremity showing a fringe of ragged strands, like that of a broken rope. The immensely more extended scale of the action here being kept in view, and the fact that the whole spot is being changed in all its parts—even while we are looking at it—by alterations which, though apparently gradual, are really the indications of an immense energy, it will be seen that, considered merely as a spectacle of the play of natural forces, we have before us something almost incomparably greater than any which the terrestrial volcano, earthquake, or cyclone, can offer. The entire surface of the earth, were it spread out into a plain, would be, in fact, of inconsiderable size as compared with either branch of the spot we are examining.

The quickness of the transformations that the observer sometimes notes here is wonderful. Lockyer, Young, and other observers, have demonstrated the existence of chromospheric movements, in some instances, at the rate of over 100 miles a second; and the velocities in the photosphere are, occasionally, of a similar order of magnitude. As an instance, it may be mentioned that the loop in question, which inclosed an area of about 3,000,000 square miles (not far from that of the United States), broke up, and seemingly melted away, like a snow-wreath before a fire, in little over a quarter of an hour. How vain the attempt must be to adequately realize to ourselves the features of such a cataclysm seen close at hand!

It is quite impracticable to convey an adequate idea of the complexity, strangeness, and beauty of these penumbral forms by an engraving; and the description is likely to fail equally, both on account of the unlikeness of the appearances to any thing with which we are familiar, and the difficulty of using any descriptive terms which, drawn from terrestrial analogies, will not here prove inaccurate. A plume-like form, in the upper portion of the spot, is necessarily but an imperfect memorandum of an appearance, in reality all but impossible to render with the pencil, even on a scale which depicted it a hundred times this size. It might be likened to a sheet of glass, covered with

the most intricate and capricious patterns the frost ever traces on our window-panes in winter; but, together with this, there was something flame-like in the graceful terminal curves, and something strangely suggestive of fern-like vegetation about the whole. This double and apparently incompatible impression of something at once crystalline and plant-like is strikingly conveyed by many of the penumbral forms, and yet the description will doubtless appear incongruous to any but the few who have seen for themselves. The comparison of the frost-figures is the least inapt, perhaps, to be found, but it is really impossible to obtain an accurate one, when we have no single thing on earth which we can exactly liken it to. When we consider that this extraordinary shape occupied a greater area than the North and South American Continents united, while that, over the whole, obtained a temperature far above that of the white flame which plays about the mouth of a furnace, and that its parts turned, as the observer looked, from one evanescent beautiful form to another, with a rapidity of change which indicated the existence of inconceivable force, we need feel less surprise that any metaphor, necessarily drawn from our limited terrestrial analogies, should so fail to convey an adequate idea of what the writer is certain he has seen, but confesses he cannot properly describe.

The *umbra*, or dark inner shade, commences as abruptly as the penumbra, but the contrast between it and the penumbral edge is far greater than between that and the photosphere. We possess no very accurate photometric determinations of the relative light of these portions of the spot, and nothing seems practicable beyond a rough averaging where the umbræ are themselves of such various tints. If we adopt the somewhat crude determinations of the elder Herschel, we may assume that the penumbra is, as a whole, rather less than half as bright as the photosphere, and the umbra about one-seventieth of the brightness of the penumbra. More accurately, if we represent the average brightness of the photosphere by 1,000, that of the penumbra will be denoted by 469, and that of the umbra by only 7. The umbra appears, at first sight, to be black, but this is only from contrast with the superior brightness around it. It is certain, for instance, that sunlight is at least 200,000 times brighter than moonlight (probably more). The umbra, then, if it be but seven thousandths of the brightness of the surface, is still 1,400 times (at least) as bright as the moon, or far brighter than the calcium-light. The absolute depth of the inner edge of the penumbra, below the surface, is not very great, according to M. Faye, and probably not over from 2,000 to 4,000 miles. (Every thing is relative; and, on the sun, 2,000 miles is little for the depth of a cavity which may be from ten to twenty times this width.)

Somewhere about this lower level commences the umbra, which has been already compared to the spout of the funnel, of which the penumbra formed the upper shallow cone; and, through these umbral shades, the eye looks down to quite unknown depths.

The darkest parts are far from being black, however they may appear by contrast, the very "blackest" part being radiant with a light which would appear intolerable to the unshielded eye. Brown and reddish tints are occasionally seen here with the polarizing eye-piece. These, the spectroscope shows, are due to incandescent hydrogen; but a common tint, which is particularly that of the nuclei or deeper umbral shades, is a very pure violet.

It is impossible to do more, in such an article as this, than to outline, in the briefest way, a few of the more prominent appearances of the spots and solar surface, without attempting any description of the laws which regulate their respective motions, and the emission of their light and heat, and without alluding to the numerous other topics of interest to the student. The reader will not, it may be hoped, on this account derive the impression that his attention has been invited to a description of superficial solar phenomena, merely as spectacles. In this point of view alone, certainly, we cannot contemplate them without lively wonder, but their deeper interest will lie in the light they shed on the nature of the sun itself, and the laws which govern that flow of light and heat through which alone we ourselves live and move. Experience seems to indicate that, according as these wonderful phenomena are studied with or without the spectroscope, they are assimilated more, in the observer's mind, with such terrestrial motions as those we call eruptions in the first instance, or cyclones in the second. It would be generalizing from a partial view, therefore, to present the reader with any single hypothesis at present, especially while those versed in the study find so much that, on any hypothesis, is still mysterious.

FERMENTS, FERMENTATIONS, AND LIFE.

By FERNAND PAPILLON.

TRANSLATED BY A. R. MACDONOUGH.

I.

UNTIL very lately, all fermentations were supposed to be produced by the spontaneous decomposition of organic matter within a fermentable liquid. It was said that on contact with air this organic matter undergoes a special change which gives it the character of leaven, and this was regarded as an agent having the power of spreading decomposing movement. It is true, brewer's yeast had long been well known; the facts of its cellular composition and its organization were familiar; but no relation was recognized between this organized condition and those phenomena of fermentation produced by yeast in saccharine liquids, such as grape-juice or the wort of

ale. In the first few years of this century Turpin, and afterward Cagniard-Latour, attempted in vain to prove that such a relation existed; it was always denied that any thing else could be observed in alcoholic fermentation than an operation resembling all those slow decompositions that were classed among fermentations. We have admitted, in our time, that alcoholic fermentation, instead of being an exception, is on the contrary the very type of the phenomena we are treating of; that the yeast-cells, far from being unimportant, take an essential part in it, and that in all fermentations whatever there occur low organizations, microscopic corpuscles, more or less analogous to those of yeast. At least this is the first result of investigations carried on in the past fifteen years by several men of science, among whom in the first rank M. Pasteur is to be cited.

M. Pasteur began the course of his labors in 1858, by the study of alcoholic fermentation. He placed it beyond a doubt that, in the case of grape-juice or beer-wort, as in that of any other saccharine liquid exposed to the air, the more or less rapid production of alcohol is always connected with the production of a microscopic fungus, consisting of rounded globules, a few thousandths of a millimetre in diameter. These globules, known under the name of brewer's yeast, multiply in the fermenting liquid at the expense of the organic matters it contains, and, by the exchanges of growth they give rise to, produce decomposition of the sugar into alcohol and carbonic, succinic, and glyceric acids. These are the four invariable products of alcoholic fermentation. Sugar is the food of the yeast-fungus; these products are its excretions. The laws of the inner mechanism that elaborates them are yet unknown. But every thing leads us to believe that the yeast-cells secrete a substance more or less resembling those that work out the phenomena of digestion in the higher animals. Alcoholic fermentation would thus be a kind of digestion of sugar within the globule.

M. Dumas, who signalized his entrance upon the career of studies in natural science half a century ago, by memorable discoveries in microscopic physiology, has lately returned to researches of the same kind, precisely, in respect to fermentations. In M. Pasteur's laboratory at the Normal School he has taken up investigations on this subject, the results of which, quite lately published, show that the distinguished *savant* in question has lost neither his cautious diligence in experimental processes, nor his lucid conception in the grasp of principles. He has attempted among other things to determine the decomposing force, the amount of activity, possessed by each cell of the alcoholic ferment. To ascertain this, he measured the quantity of sugar decomposed in a given time by a fixed weight of yeast, and he found —after first establishing that a cubic millimetre of yeast contains about 2,772,000 cells—that the power of a million of cells represents the force capable of decomposing four grains of sugar in an hour. If we attempted according to this estimate to express in figures the number of cells

employed in producing the wine, beer, and cider, consumed every year, as M. Dumas says, even astronomers would shrink from the task.

This active property of decomposing sugar, and forming alcohol in consequence, does not belong to the cells of brewer's yeast exclusively. Several chemical agents possess the same power, and certain vegetable cells also are adapted to use it. When fruits are placed in a medium filled with oxygen, they absorb this gas, and occasion the release of carbonic acid; if, on the contrary, they are left in carbonic acid or any other inert gas, they effect the production of alcohol. The fruits remain firm and hard, without suffering any external change, but the sugar they contain is transformed in part into alcohol. How is this phenomenon to be explained? In common air, the cell of the fruit is fed by oxygen; if this gas is withheld, it is forced to borrow the materials of nutrition from the fluids that moisten it, that is, from the saccharine juice, and then the latter is decomposed. M. Pasteur has noted that a similar alcoholic fermentation takes place in other vegetable organs, in leaves, for instance, and in every case he has proved that the phenomenon is due to the cells of the vegetables alone, and not to yeast-globules. Far from throwing any doubt on the physiological doctrine of fermentation, these singular facts agree in lending it support, by giving it deeper and more general application.

We have seen that the fermentation of sugar yields alcohol. The latter, brought in contact with certain porous substances, as, for instance, platinum sponge, can absorb the oxygen of the air and transform itself, by oxidation, into acetic acid. A phenomenon of this kind occurs in wine when it sours, the alcohol contained in it being changed into acetic acid; only, the agent in the transformation is in this case a microscopic plant, made up of little elongated globules, some thousandths of a millimetre in diameter. These globules, these mycoderms, develop on the surface of wine exposed to the air, and form a scum which plays the part of storing away a certain stock of oxygen, afterward used to produce acetification in the liquid. This scum, which is called mother of vinegar, only acts while in communication with the air. As soon as it is below the surface, it loses its efficacy, and the production of acetic acid is checked. Thus the development of vinegar in the acetic fermentation is reduced to an oxidation of alcohol, in which microscopic cells are the vehicles of the oxygen.

When milk turns and sours, that phenomenon also is due to the formation of an acid—lactic acid. This substance proceeds from the decomposition of sugar contained in the milk, and this decomposition, again, is a fermentation. The microscopic being that effects it assumes several forms; sometimes it is made up of cells presenting much resemblance to the cells of yeast, sometimes it consists of straight and exceedingly fine rods. Milk also contains casein, which is the substance that composes cheese, and, when the fermentation of the sugar in milk is over, that of the casein begins; after lactic acid, butyric

acid is produced. Examining with a microscope the casein transforming into butyric acid, we observe in it little rods, two thousandths of a millimetre in diameter, and of a length from two to five times as great; this is the butyric ferment, which, concurrently with other microscopic vegetable growths, determines in various cheeses the slow production of butyric acid and several analogous acids, equally strong in smell. To cite a last illustration, the decomposition of urine, giving rise to an abundant release of ammoniacal gases, is also the result of a fermentation; under the action of cells smaller than those of brewer's yeast, the contained urea changes to carbonate of ammonia, rendering the liquid highly alkaline and strongly odorous. In short, the fermentations we have just described, and many others of the same kind, participate in the nutrition and development of microscopic beings, of an average size not exceeding some thousandths of a millimetre, and presenting the form sometimes of spheroidal or of egg-shaped globules (as mycoderms, torulacea), sometimes of straight, bent, or curving rods (as vibrios and bacteria). These diminutive beings engender the ferment within the fermenting liquid itself, in the degree and rate of their propagation in it.

There is another class of fermentations in which the immediate presence of definitely-shaped corpuscles cannot be traced. Thus diastasic fermentation consists in the transformation of starch into sugar under the action of a formless yellowish matter, called "diastase." Amygdalic fermentation is that in which amygdaline becomes the essence of bitter almonds, by the action of a like ferment, known as "syraptase." The former takes place in the vegetable embryo when the amylaceous matter of the seed is converted into a soluble sugar, which permeates the growing tissues of the plant. The latter occurs when bitter almonds are crushed in water; on contact with the liquid, the mixture of these odorless kernels takes the characteristic smell of the essence of bitter almonds, which results from the fermentation of amygdaline. We regard as fermentations, moreover, a certain number of similar phenomena which can be produced with the implements of a laboratory, and which are constantly taking place in living organisms, of which the cause is a zymotic substance. There exists, for instance, in the saliva a principle called ptyaline, which, like diastase, converts amylaceous matter into sugar. The gastric juice contains another principle, pepsin, which has the effect of liquefying albuminous substances, so that they may be prepared for absorption. The pancreatic fluid contains another principle which acts in a similar way. Digestion is thus reduced to a series of fermentations, as the ancient chemists had rightly conjectured in regard to it. These different phenomena, as well as those in which organisms take part, have the two general characteristics of fermentation; they occur only within certain limits of temperature, and the weight of the fermentable matter is always much greater than that of the ferment which suffices to decompose it.

To conclude, fermentations occasioned in certain media, by the act of development and nutrition of ascertained microscopic animal or vegetable existences, present a group of well-defined characteristics. They follow obediently all the variations that may occur in the physiological activity of the microscopic beings contained in the liquid. This does not go into fermentation all at once; it delays more or less, and molecular movement makes itself perceptible in it by degrees. The phenomenon is one of evolvement. This appears to be the characteristic of alcoholic, lactic, acetic, butyric, glyceric, and putrid fermentations—all of those, in short, which M. Pasteur has studied with so convincing accuracy. Is it the same with the conversion of amylaceous substances into sugar, under the influence of diastase or ptyaline, with the dissolving of proteic substances by pepsin, with the change of amygdaline into the essence of bitter almonds, by contact with synaptase? Evidently not. These phenomena present another aspect; they show no stages of evolvement. Doubtless they require a certain time for their completion; but they take place all at once, and without any relation to the surrounding air.

These differences between the two kinds of fermentation clearly depend on this: that, in the former, the phenomenon is subjected to the conditions and vital progress of those organized corpuscles which elaborate the ferment within the substance of the fermentable liquids, while, in the latter, the phenomenon is brought about by a ferment already formed and prepared. But this latter ferment is no less of organic origin; it, too, arises from living beings, animal or vegetable. Whether it emanates, like diastase, from the young cells of the seed, or results, like pepsin, from work done in the digestive apparatus, it is the labor of life, just as much as if it had been completed by globules of yeast or bundles of bacteria. Thus the efficient sources of all fermentations are the same. All ferments are at bottom alike, whether procured directly for the fermentable liquid by microscopic bodies inhabiting it, or emanating from corpuscles that inhabit elsewhere. The true doctrine of fermentations consists in this point.

Henceforth, then, we may consider ferments as products of a fecundation taking place in cells, as secretions elaborated by those myriads of infinitely little corpuscles, some crowded, squeezed, condensed, into the palpable organs of animals and plants—others free and moving, disseminated, as we shall see, into vast, intangible space. The energy which distinguishes these microscopic animal and vegetable growths also belongs to the microscopic elements making up the living tissues in the higher animals. We must give to this property, hitherto considered as special, the high dignity of a fundamental and universal attribute of organized cells. We must detect, in the most complex conversions and processes of nutrition in superior beings, the same untiring and primitive force that marks the subtile action of invisible and insignificant monads.

No doubt, the corpuscles of different species—to which, in the last analysis, we reduce animals and plants of every kind and degree—are not identical. Each species has its own structure, its specific energy, its mode of nutrition, its fixed secretions—characteristics, moreover, which vary with circumstances and media. Yet we can point out more than one interesting similarity between certain ones of these species, which seem to discharge quite distinct functions, and hold very unlike stations, in the vast harmony of vital monads. The cells of fruits, when placed in certain conditions, behave, as has been seen, like the cells of brewer's yeast; they both decompose sugar and yield alcohol. We may trace resemblances not less close, as M. Blondeau and M. Pasteur have done, between acetic mycoderms and blood-globules. Both alike serve as carriers of oxygen—the first, for the slow combustion of alcohol; the last, for the slow combustion of the albuminoid matters in animal tissues. It is even likely that there is a principle in mycoderms similar to hemoglobine in the blood-globule, and provided with a special affinity for oxygen. However this may be, comparisons of this kind open a new path for physiology. As that science is definitely summed up in the explanation of existences and processes in the microscopic elements of organs, it is plain that nothing can be more useful to it than the study of these one-celled organisms in which the phenomena are extremely simple, and life is reduced, in a manner, to its primitive factors. It becomes more and more evident that progress in the comprehension of the superior animals is bound, with the very closest ties, to advance in the comprehension of the mechanism of nutrition in the rudimentary units of life, in the smallest beings that it is given us to study.

II.

Now, whence come those organized microscopic corpuscles to which, as we have seen, very many of the alterations of organic matter must be attributed? Upon this great problem, opinions at this day are still very contradictory. Neither patient observations, nor minute experiments, nor profound reasonings, have been wanting; yet some still believe that these little bodies grow, by spontaneous generation, within fermentable liquids, while others assert, and profess to have proved, that they come from germs contained in the air. Certainly, the former opinion involves nothing contradictory nor impossible. Those who reject it by begging the question, in the name of some unknown, mystical doctrine of life, do not even deserve to be listened to in the investigation. It might possibly have occurred that organized beings should be produced, complete at all points, in a medium deprived of organization; yet experiment proves that this does not occur. We must, then, accept the other opinion—the panspermist doctrine—that is to say, we must concede that the germs of microscopic animals and vegetables, with which so many fermentations and putre-

factions are connected, exist in the air. This is one of the conclusions, and perhaps the most legitimate and most fertile one, of M. Pasteur's striking studies.

He deserves the glory of it precisely because he has not priority in it. In truth, the originator of this idea only had, and could only have, a dim intuition of it. He could measure neither its importance nor its consequences. The importance and the results of a great idea, whatever it may be, only become apparent when, after undergoing a certain evolution, it has gained the precision, certitude, and establishment, that nothing but long experience can confer upon it. A conception must have acquired some age in science to wear a fixed authority, and bestow fame on those who comprehend, and cause to be comprehended, all its grandeur and power. The circulation of the blood had long been seen by glimpses, in the schools of physiology, when Harvey gave it complete and vigorous demonstration. Gravitation had long invited research, and suggested presentiment, before Newton drew its perfect system. So, too, the panspermist theory, neglected and ignored since the time of its earliest authors—among whom Astier, in 1813, deserves particular mention—has only been definitely established in our time, through the experiments made by M. Pasteur. These experiments, repeated and varied in a thousand ways, all refer to the investigation, by comparison of what takes place in the same fermentable liquid, under the different conditions of exposure to common air, filled with dust, and of contact with purified air. For instance, M. Pasteur puts a certain quantity of a liquid, that readily undergoes change, into glass balls through which a current of air may be made to pass. Fermentation and the development of small organisms take place very soon in the balls through which common air circulates; but, if the air, before entering them, passes through a plug of cotton, no change in the liquid is observed. When the volume of air, thus filtered through cotton, is considerable, the plug is so filled with dust as to turn black. Now, this dust, in addition to a quantity of mineral particles, and fluff of many kinds, contains spores and germs of fermenting substance, as is proved by the fact that the smallest quantity of it, sprinkled in pure liquid, will produce fermentation in it. An experiment of another kind is this: M. Pasteur, by an ingenious arrangement, inserts and withdraws from a glass jar, filled with pure air, the juice from the inside of a single grape, so that, during the experiment, the juice communicates neither with the surface of the grape nor with the atmospheric air. The juice, thus obtained, shows no trace of fermentation, remaining unchanged as long as the jar is closed; but, if it is opened, or if its contents are mixed with a few drops of water in which the surface of the grape has been washed, fermentation is set up in it at once. This is because the outside of grapes is always covered with yeast-germs, even when the bunches have been subjected to constant rains. In this case, plainly, fermentation is due

to the germs suspended in t! air, or deposited on the surface of the grapes and stems. M. Pasteur draws blood from an animal's veins by a similar process, and introduces it into a glass vessel in contact with pure air. The blood continues fresh for years. M. Pasteur asserts and proves by experiment that grape-juice, milk, blood, and all liquids that most readily undergo change in ordinary conditions, are incapable of fermentation in air which is pure, that is to say, deprived of the corpuscles it contained.

M. Pasteur has made still another set of experiments. He has obtained development of fermentation in liquids freed from albuminoid substances. It was supposed, before his researches, that the cells remarked in the fermentation of grape-juice proceed from the conversion of the albuminoid substances which this fluid contains in its natural state. M. Pasteur prepares a solution of sugar, tartrate of ammonia, and some other salts, and sprinkles a few yeast-globules in it. They swell, develop, and propagate in this artificial medium quite as well as in the grape-juice. So it was supposed that in the acid fermentation of milk the ferment is a product of the conversion of casein. M. Pasteur proves that supposition to be unfounded, by artificially producing the lactic ferment in a compounded liquid containing not a trace of casein. These very delicate experiments have not only increased the vogue of the panspermic theory, but they have been of great value also to vegetable physiology.

Many objections have been raised to these theories on the origin of ferments, to which M. Pasteur has almost always replied by unquestionable facts and solid reasonings, though he has sometimes done himself the injustice to be rough and contemptuous in discussion toward his opponents. Truth is strong enough to indulge charity for error. The gravest of these objections, it must be said, have applied to problems which do not concern the very foundation of the dispute between the panspermist system and its opposite. For instance, M. Trécul, the skillful and noted micrographer, M. Béchamp, and others, have proved that M. Pasteur mistakes with regard to the evolutions and transformations undergone by microscopic beings in fermenting media. M. Pasteur has certainly made more than one mistake on this subject, and there probably does exist between certain ferment-corpuscles a closer relationship than is supposed at the laboratory of the Normal School; but that does not in the least alter the fundamental character of the theory. Attention is also called to the fact that corpuscles with a determinate structure can be produced complete, without germs, in some liquids. No doubt this is true, but only on condition that the liquids are living ones. No doubt the cambium of vegetables, the blastema of animals, and generally all protoplasmic fluids, are fertile hatching-fields for the spontaneous development of the cells and fibres of living tissues. It is thus that the first elements of the embryo show themselves in the animal ovule. And in this respect the

labors of Robin, Trécul, Onimus, Legros, and a great number of other observers, are decisive; but life is the property of these protoplasms; they depend upon an organized system. In the depths of the organism, and shielded from the air, they toil at the creation of microscopic corpuscles. Place them in contact with purified air, in M. Pasteur's glass globes, and then they would be barren.

The last objection M. Pasteur has to meet is, that, if the germs of all these microscopic vegetable and animal lives are in the atmosphere, they should be discovered and recognized there. But, in examining the dust of the air microscopically, we do not by any means detect all the rudiments of that infinitely minute flora and fauna whose existence is attested by the fermentations and putrefactions of organic matter. M. Pasteur has thus far met this argument only by the evidence of his experiments which prove that, in contact with purified air, neither fermentations nor putrefactions are possible. That is strictly sufficient, but we can go farther. It is by no means a sure conclusion that these germs do not exist, because many of them are invisible under the lens. To begin with, we do note with certainty a certain number of species in atmospheric dust. It is therefore an admissible presumption that, if the remaining ones elude our eyes and our microscopes, that merely proves them to be smaller than the observed ones. But, perhaps, the problem ought to be viewed in a different way. We believe that these visible germs are the exceptions, that is, that they are beings already arrived at a certain degree of development, and that, in reality, all true germs are of dimensions forever beyond the reach of microscopic observation, even conceiving lenses to be immensely more powerful than they now are. The microscope barely brings within our range of vision points that measure at least a ten thousandth part of a millimetre. The primitive germs of life cannot even approach the millionth part of a millimetre. Physics and metaphysics both assure us that we must here give up the hope of measuring and estimating things according to the powers of our limited senses. An effort is needed to pursue with the mind's eye these perpetually-dwindling dimensions, still to go on though the imagination fails in the task, and to realize at last how far removed are the bounds of the microcosm. If the faculty of reaching out beyond the limits of our nature, which is one of the noblest prerogatives of our intelligence, does not desert us, we attain to the idea of the vital monads of Leibnitz, the organic molecules of Buffon, the comprehension of existence for primal organisms diffused throughout the world by myriads of myriads, and the conception of the infinitely minute within the infinitely minute.

Thus, just as the infinite universe through which the spheres roll is filled with invisible particles of a subtile matter to which physicists and astronomers give the name of ether, and which supplies the only key to cosmic phenomena, the finite universe in which organization unfolds itself is thronged with corpuscles no less invisible, forming

what the illustrious Ehrenberg calls the milky-way of lower organisms, and no less essential for explanation of the processes of which we have traced the general course. As there is an ether wanting in life, so there is an ether endowed with life—a vital ether. Both are above denial; they surpass our reason, yet reason cannot but demand them. They elude the close grasp of experiment, yet experiment does not permit them to be avoided; they are unseen, and without them there could be nothing seen. The mind clings to them with the stress of all its power to embrace, perhaps because it feels a secret, mysterious affinity with them, perhaps because it is in substance of the same essence with them.

III.

Our atmosphere, then, is the receptacle for myriads of germs of microscopic beings, which play an important part in the organized world. Penetrating agents of decay, baneful toilers for disease, they lie ever in wait for the chance to pierce the internal machinery of animals and plants, and create slight or grave disturbances within it. Life often resists or escapes them, but nothing can contest with them its deserted vesture. The corpse is their natural aliment, and death their chosen laboratory. There these lowest of created things work out their lofty destiny in the eternal drama of renewal of organic existences.

When the thin pellicle covering sweet fruits is torn at any point, an opening is made for atmospheric germs. Fermenting cells pierce the interior of the fruit, and produce within it fermentation of the sugar, that is to say, the formation of a little alcohol; and this in its turn is susceptible of the passage into acetic fermentation, giving the pulp an acid taste. At last the pulp itself is destroyed by various fungous growths. When a fruit decays and takes a more or less unpleasant flavor, this depends on the intervention of ferment-cells of atmospheric origin, and on the production of acid or alcoholic substances. An able micrographist, M. Engel, who has lately studied these phenomena minutely, discovers that the yeast-cells which thus produce alcoholic fermentation in the juices of fruits present some slight differences in various fruits, neither do they have the same morphological character as those of grape-must or beer-wort. Varieties occur in these cases, corresponding to the different media in which the nutrition of the little fungus takes place.

The microscopic fungi of the atmosphere play as interesting a part in the alteration of wines. These grow acid, change, become filmy or oily, or take on besides a decided bitterness. All these sicknesses depend on the development of different little plants recognized and described by M. Pasteur; and this scientist, not stopping at the solution of the nature of these disorders, has sought the means of preventing them. Resting on some former observations by D'Appert, he conceived the idea of subjecting wines to the action of a very high degree

of heat, so as to destroy the yeast-germs. There was no possibility of doubt as to the destruction of these germs and the prevention of any further change, but it might well be asked whether the delicacy and bouquet of certain wines would not be endangered by the effects of heating. Long-continued experiments prove not only that heating is an excellent method for preventing sickness in wines, but also that, instead of impairing their exquisite qualities, it ripens and strengthens them. The recorded minutes of tastings officially performed during the past year by several members of the syndical wine commission, at the suggestion of M. Pasteur, contain decisive testimony on this point. Fine Burgundy wines, heated in bottle seven years ago to temperatures varying between 131° and 149°, appeared, at the end of that time, superior to the same wines not so treated. Persons who spoke with some authority, M. Pasteur says, declared that heating would in time deprive the wine of its color. The contrary is the case, when the air is excluded during the process; the color grows livelier by heating. It was said that heating would in time alter the bouquet of fine wines, giving them dryness and too great age. On the contrary, the bouquet seems to be heightened with the lapse of time, more positively than with wines not heated. In the case of chambertin and volnay particularly, the tasters noticed this fact. M. Pasteur was led by these studies to investigate the cause of the aging of wines, and he discovered that the phenomenon was due to slow oxidation. Wine kept in glass tubes completely filled and closely sealed does not age. By increasing and regulating the aëration of wine, and particularly combining it with heating, he succeeded in manufacturing in one month excellent old wine. In short, oxygen and heat, acting on wine in certain proportions, promote instead of hindering the development of those volatile principles to which the liquid owes its perfume and part of its flavor; but this discovery is additional to those sought. What M. Pasteur did chiefly look for and did find, in giving exact and methodical rules for heating wines, is a process, applicable on a great scale, for preventing the diseases from which the common vineyard products so often suffer, and that fortunate application is a result from his researches on fermentation generally. In the same way, in consequence of the examinations he undertook as to the share of microscopic organisms in the diseases of silk-worms, he was led to prescribe a practical way of hindering the development of these organisms, and thus preventing the malady.

When we inject into the subcutaneous cellular tissue of a living animal a putrefied or septic liquid, that is, one containing those thread-like corpuscles known by the name of vibrios and bacteria, it sometimes happens that the animal experiences no inconvenience. Dogs particularly resist with vigor the poisonous influence of such a fluid, but the case is different with other species, and notably with rabbits. The system becomes the seat of grave phenomena, almost always mor-

tal, of which the general group composes the affection known by the term *septicæmia*. The microscopic organisms in such a case poison the animal, not only by the mere fact of their presence in the blood, but besides and especially because they develop and propagate in it with astonishing rapidity, in the same way that yeast reproduces itself in barley-wort. But the most singular thing in these pathological fermentations is the fact noted some years ago for the first time by MM. Coze and Feltz, and the study of which M. Davaine took up last year. Davaine demonstrates, by experiments made on rabbits and Guinea-pigs, that one drop of blood, from an animal affected with septicæmia, has the power of imparting the infection to another animal inoculated with it, that a drop taken from the second can transmit the disease to a third, and so on. Still more, very wonderfully, the poisoning power of the blood of these animals increases with the degree of advance in the series of inoculations. The culture of the virus heightens its maleficent properties. This gradual increase of the virulent force is such that, if we take a drop of blood from an animal representing the twenty-fifth term in a series of successive inoculations, and so dilute this drop with water that a drop of the dilution corresponds to one trillionth of the original drop, we get a liquid of which the smallest quantity still displays mortal activity. These experiments of M. Davaine, which exhibit the degree of venom as increasing in an inverse ratio to the apparent quantity of the poison, have been repeated and confirmed by several eminent physiologists, among others by M. Bouley, and have produced a sensation which still continues in the schools of physiology and medicine. Apart from the inherent difficulty of forming a notion as to the influence of those infinitesimal doses, they seemed to yield an argument of a kind to support the assertions of homœopathy. If the difficulty is real, though it may be got over, the argument, we take leave to say, is worthless. Let us look at the difficulty first. This drop which is still mortal, though representing only an infinitely small fraction of the original quantity of poisonous matter to which it is distantly related, permits no corpuscle to be detected. That is true, yet it contains the germs of them, and germs such in number, size, and reproductive power, that nothing prevents them from breeding again indefinitely, in spite of all efforts tried to get rid of them. The discussions that have just occurred in the Academy of Medicine on this grave subject, almost at the same time that the question of ferments was under debate in the Academy of Sciences, leave no doubt as to the reality of this progressive breeding of virulent germs by culture. But is this any argument for the homœopathists? None whatever. They attribute curative effects to extremely small doses of certain inorganic substances most evidently inert, which can in no way reproduce themselves. If the virulent elements occasion disturbances so profound in animal organisms, it is not by reason of their extreme minuteness, but it is because they multiply with prodigious

rapidity in the depths of the tissues and humors, where they labor in a manner opposed to the harmonious life of the body.

However this may be, the vibrios and bacteria have an undeniable share in the production of human maladies. They are found in the blood of persons attacked by infectious disorders, and if in many cases their relation to these disorders is only that of concomitants, in others, their relation of causality is very clearly ascertained. Thus M. Davaine's investigations prove that the maladies called carbuncular, so formidable in men and animals, are due to the excessive development of a species of bacteria in the blood. Typhoid fever also seems to acknowledge a cause of the same kind. Rabbits die from inoculation with blood taken from men attacked by this disease. Our knowledge upon this difficult subject, it must be owned, is very little advanced, in spite of the ardent labors devoted to its extension in the past few years. The illusions of the microscope and the exaggerations of a spirit of routine too often impair the value of studies undertaken in this direction. Without going so far as does the opinion of those who attribute all these disorders to microscopic corpuscles, and regard all morbid phenomena as fermentations, it must at any rate be admitted that these corpuscles, diffused throughout the air, take an important place among the eternal enemies of health. At all times surgeons and physicians have recognized the danger from penetration of common air into the interior of the organism, by the way of wounds or otherwise. We now understand the explanation of the danger. It is not the gases of the air that are dangerous; but the proto-organisms contained in that fluid must be charged with the fatal influence it exerts in traumatic cases, and putrid infection has no other origin. Thus the anxiety of practitioners now is to protect wounds from access by the germs in the air, by means either of impermeable coating, or of antiseptic dressings, containing alcohol or phenic acid, or by pneumatic closing up, or by filtration of the air itself through cotton. Under the influence of ideas distinctly introduced into science by the researches we have just reviewed, several practices in surgery have undergone great modifications.

After examining the alterations produced in the living, we have to consider those occasioned by fermentations in the dead. When life has retreated by slow degrees from all the parts of an organized being; when, after all partial deaths have occurred, total death has possessed the depths of the subject, and broken all the springs of its activity, the work of putrefaction begins. Its task is to unmake this body, to destroy its forms, and dissever its materials. The work to be done is to disorganize it, to reduce it into solids, liquids, and gases, fit to go back again into the vast reservoir whence new life is incessantly issuing. This is the task that heat, moisture, air, and germs, will undertake in unison. It is all performed with steady diligence. Nature knows no delays; as soon as the body is cold, the protecting coating that covers

all its surface, the epithelium, decays in places, particularly in the moister parts. The agents of disorganization, vibrios and bacteria, or rather the germs of these thread-like corpuscles, penetrate through the skin, wind into the small ducts, invade the whole blood, and by degrees all the organs. Soon they swarm everywhere, almost as numerous as the chemical molecules in the midst of which they stir and circle. The albuminoid matters are decomposed into fetid gases, escaping into the air. The fixed salts, alkaline and earthy-alkaline, slowly release themselves from the organic matters with which they combined to form the tissues. The fats oxidize, and grow acrid; the moisture dries away. Every thing volatile vanishes, and, at the end of a certain time, nothing remains save the skeleton, but a formless mingling of mineral principles, a sort of humus, ready to manure the earth. Now, all these complex operations absolutely required the intervention of the infusoria of putrefaction. In pure air, deprived of living germs, they could not have been accomplished. To check putrid fermentations, to insure the conservation of animal or vegetable substances in a state of perfect integrity, only one means avails, but that is an infallible one—that of thoroughly precluding the access to them of the aërial germs of vibrios and bacteria. Whether we adopt D'Appert's method and begin by subjecting these substances to the action of high temperature, preserving them after that in hermetically-closed vessels; or whether, as we have seen very lately practised by M. Boussingault, we introduce them into an extremely cold medium; or whether we saturate them with such salts as have antiseptic properties, in every case they are protected from putrefaction by paralyzing the effect of the lower organisms. The corruption of animals is not more possible than the fermentation of grape-juice, barley-wort, milk, etc., when it is made impossible for the germs to act. This is another fact demonstrated by M. Pasteur.

We have just used the term antiseptic, that is, capable of destroying germs, and preventing the action of ferments. The interest connected with such substances is easily understood. In truth, they are at the present time the chief objective point of therapeutic researches. At the same time that chemists and physiologists are engaged with persevering zeal in studying the functions of microscopic corpuscles in living Nature, physicians, perceiving their manifold and baneful activity in the production of disease, are seeking the means of reaching and destroying them. Every one knows those principles, like phenic acid, which are extracted from pitch, and are also found in smoke, to which they impart antiseptic properties that have been utilized from time immemorial. Other substances have been lately discovered, not less remarkable for their energetic resistance to fermentation and virus. Among the number are the alkaline sulphites and hyposulphites, which have been the object of very interesting examination on the part of an Italian physician, M. Polli; the borates and silicates of potassa and

soda, to which M. Dumas invited the attention of physiologists a year ago; the acetate of potassa, and others. Hitherto the physiological virtues of active principles have been studied only with respect to the higher order of animals: M. Dumas pointed out the great interest there would be in examining the influence they exert over the lower organisms charged with the elaboration of ferments, and over ferments themselves. Such researches not only contribute to a better knowledge of the mechanism itself according to which these principles affect the system of vital phenomena, but they also gain the most useful indications for the healing art. Indeed, beginning with the moment at which M. Dumas and other chemists made known the result of their examinations on this subject, coincident also in time with the experiments of M. Davaine on septicæmia, a vast number of attempts were entered upon, in hospitals and in laboratories, to discover to what extent these anti-fermenting substances hinder morbid fermentations. These attempts are still proceeding; we cannot foretell their success, but we are authorized even now to say that they will not be barren of advantage to the healing art. In this, as in all other departments of scientific activity, we see abstract studies result in useful discoveries.

As a general statement of the subject, all this immense work of fermentations, putrefactions, and corruptions of organic matter, is effected in the world by a small number of species of microscopic cells and filaments, by fungi and spores of the lowest order, of which the germs fill our atmosphere. This is one of the most certain acquisitions of modern science, one of the most important from the point of view of natural philosophy, one of the most productive for those arts that are concerned in improving the condition of mankind. We may now regard it as firmly established; but let us not forget that its establishment has cost two centuries of investigations and labors. Leuwenhoek, in the middle of the seventeenth century, was the first to reveal the microscopic world of the air, and to conjecture its momentous functions. What severe toil, what struggles and tedious trials, since the observations of the Dutch micrograph, to the time of the experimental studies of our contemporary and compatriot, M. Pasteur!

BIRDS-OF-PARADISE.

By JAMES H. PARTRIDGE.

THE Birds-of-Paradise are a small, but renowned family. They received their name from the idea, entertained at one time, that they inhabited the region of the Mosaic paradise. They live in a small locality in Australasia, including Papua or New Guinea, and a few adjacent islands. They are not easily tamed and kept confined; and few have been brought alive from their native locality. Mr. Beale

had one at Macao, China, that had been in captivity nine years; several have been kept at Amboyna, but very few have ever been carried to Europe, although specimens of the skins and prepared birds were taken there more than 300 years ago. Anthony Pigafetta, one of the companions of Magellan, first imported them into Europe in 1522.

In form and size they somewhat resemble our crow, or blue-jay; but some are smaller. They are usually included in the tribe of cone-bills, though their bills are quite slender for that group, and a little compressed. The bills are covered at the base with downy or velvety feathers, which extend over the nostrils: their wings are long and round; the tail consists of ten feathers, two of them, in some species, very long; legs and feet very long, large, and strong; outer toe longer than inner, and joined to the middle one toward the base; hind-toe very long; claws long and curved. But they are chiefly remarkable for the wonderful development of various parts of their plumage, and for the metallic splendor of its rich hues. The sides of the body, and sometimes of the head, neck, breast, or tail, are ornamented with lengthened, peculiarly developed, and showy feathers. Says Wood: "In all the species, the feathers glow with resplendent radiance; in nearly all there is some strange and altogether unique arrangement of the plumage; and, in many, the feathers are modified into plumes, ribbons, and streamers, that produce the most surprising and lovely effects." The plumage of the face, breast, and throat, is usually the richest in metallic tints, while other parts frequently have very beautiful and brilliant colors.

Their food consists of grasshoppers, butterflies, moths, and other insects; figs, the berries of various trees and shrubs; seeds, rice, and other kinds of grain. During the heat of the day they remain concealed in the woods, but, in the morning and evening, come forth to seek their food. Furious storms frequently bring them to the ground, when they are easily taken by the natives, who also shoot them with blunt arrows, or take them with a noose, likewise with bird-lime, or other glutinous substance, placed on the branches which they frequent. They sometimes stupefy them with *cocculus indicus*. Europeans shoot them with shot-guns. The natives formerly skinned the birds, cut off the legs and wings, and dried the skin on a stick. Later they took out the interior organs of the bird, cut off the legs, and smoked the birds with sulphur, or seared them inside with a hot iron; and, after being thoroughly dried, they put them in the hollow of a bamboo, to secure the plumage from injury. They are used by the natives, the Japanese, Chinese, East Indians, and Persians, for adorning the turbans of the men, the head-dresses of the women, and for various other purposes of ornament. The Chinese make imitations of these birds from the feathers of parrots and paroquets, to sell to strangers. The feathers were formerly, and are still, used very much as ostrich-feathers are. By their lightness and lustre, they are extremely well suited for the

ornaments of dress, and are very highly prized. In Europe and America, at the present time, they are sought for with avidity, to adorn ladies' hats, etc. The birds and feathers for the European market are principally obtained at Batavia and Singapore, whither the natives of Celebes, and others, bring them from Papua and the

FIG. 1.

GREATER PARADISE-BIRD (*Paradisea apoda*).

Arroo Islands. In India they derive much of their value from the miraculous virtues which the priests have ascribed to them, causing the creature that produced them to receive the title "Bird of God," *Manuco-Dewata;* from which Buffon coined the modern French name, *Manucode.* Dr. Forster suggests, but perhaps without reason, that this bird may have been the phœnix of antiquity.

During the dry weather of the northwestern monsoon, in our autumn and winter, many of the birds leave Papua and go west to the Arroo group; but, upon the commencement of the wet weather of the southeastern monsoon, in our spring, they immediately return to Papua. They usually fly, on these occasions, in flocks of thirty or forty, with a reputed leader. Their moulting-time is from May to August, during the southeastern monsoon. On account of the difficulty of managing their enormously-lengthened, gossamer-like plumage, they usually face the wind, whether flying or sitting. In proceeding from one place to another, they are often distressed by sudden shiftings of the wind; and, being unable to proceed in their flight against it, or go with safety before it, they are sometimes thrown to the ground. In tempestuous weather they seek the most sheltered retreats of the thickest woods. Although very active and sprightly, they are exceedingly shy and retiring in their habits. The false ideas that they were footless, lived ever on the wing, or occasionally rested suspended by the tail; fed on the dew; reared their young on the shoulders of the male, and came from the terrestrial paradise, have all had their day, but are too absurd to be more than alluded to now.

The Greater Paradise-Bird (*Paradisea apoda*), frequently called the Emerald Bird of Paradise, is smaller than the crow. Linnæus gave the specific name *apoda* to this bird, which was generally and erroneously called footless, to designate the species, not to perpetuate the error. This bird seeks the thickest foliage of the loftiest trees, in which to remain concealed during the day. The feathers on the head, throat, and neck, are very short and dense. Those round the base of the bill, and on the face, are velvety and black, changing their color to green, as the direction of the light changes; those on the throat, the front half of the neck, and the upper part of the breast, are of a bright, deep, emerald green; those on the head, back of the neck, and the shoulders, are of a light, golden yellow. The eye is at the common point between these colors. If lines were drawn from it to the throat, to the forehead, and down the sides of the neck, and curved to a point on the breast, they would indicate very well the limits of the colors. The back, wings, tail, and belly, are of a bright, reddish chestnut, the breast being a little darker, and inclining to purple. From each side beneath the wings proceed a large number of long, floating, graceful plumes, some eighteen inches in length, of exceeding delicacy of texture and appearance. These extend far beyond the tail-feathers, which are about six inches long, and "their translucent golden-white vanelets produce a most superb effect, as they cross and recross each other, forming every imaginable shade of white, gold, and orange, and then deepening toward their extremities into a soft, purplish red." From the upper part of the tail proceed two black shafts or filaments, some eighteen inches long, appearing like small wires, about one-sixteenth of an inch in diameter. The female has no

floating plumes, no gem-like feathers, and no brilliant colors. The head is dark-brown; the neck, light-brown; the upper parts of the body, wings, and tail, reddish chestnut; the breast and belly, white.

In Bennett's "Wanderings" is an interesting description of Mr. Beale's bird, at Macao. The writer says: "This elegant creature has

FIG. 2.

NATIVES OF ARROO SHOOTING THE GREAT BIRD-OF-PARADISE.

a light, playful, and graceful manner, with an arch and impudent look; dances about when a visitor approaches the cage, and seems delighted at being made an object of admiration. Its notes are very peculiar, resembling the cawing of a raven; but its tones are, by far, more varied. It washes itself regularly, twice daily, and, after having performed its ablutions, throws its delicate feathers up, nearly over the head, the quills of which feathers have a peculiar structure,

so as to enable the bird to effect this object. Its food, during confinement, is boiled rice, mixed up with soft eggs, together with plantains, and living insects of the grasshopper tribe; these insects, when thrown to him, the bird contrives to catch in his beak with great celerity; but, if, through failure to catch them, they should fall to the floor, he will not descend to them, appearing to be fearful that, in so doing, he would soil his delicate plumage; he will eat insects in a living state, but will not touch them when dead. One of the best opportunities of seeing this splendid bird, in all its beauty of actions, as well as display of plumage, is early in the morning, when he makes his toilet; the beautiful sub-alar plumage is then thrown out and cleaned from any spot that may sully its purity, by being passed gently through

FIG. 3.

RED BIRD-OF-PARADISE (*Paradisea rubra*).

the bill; the short, chocolate-colored wings are extended to the utmost, and he keeps them in a steady, flapping motion, as if in imitation of their use in flight, at the same time raising up the delicate, long feathers over the back, which are spread in a chaste and elegant manner, floating like films in the ambient air. In this position the bird would remain for a short time, seemingly proud of its heavenly beauty, and in raptures of delight with its most enchanting self; it

will then assume various attitudes, so as to regard its plumage in every direction. Having completed his toilet, he utters the usual cawing notes, at the same time looking archly at the spectators, as if ready to receive all the admiration that it considers its elegant form and display of plumage demand. It then takes exercise by hopping in a rapid but graceful manner from one end of the upper perch to the other, and descends suddenly upon the second perch, close to the bars of the cage, looking out for the grasshoppers, which it is accustomed to receive about this time."

Vanity and egotism, as usually developed, are exceedingly offensive and distasteful; but when we see a delicate creature, so richly embellished, so neat and cleanly in its habits, so fastidious in its tastes, so scrupulously exact in its observances, and so winning in all its ways, as to etherealize the commonest actions, they become not only endurable, but amusing, and even enjoyable. And if a bird, in a state of hopeless captivity, exhibits such marked traits of character, acts out so truthfully the promptings of its nature, shows so evidently its desire to please, and possesses so nice an appreciation of being admired, how perfect must be all its ways and actions, as developed in the pure, bright air, fragrant groves, and luxuriant surroundings of its native haunts!

The Red Bird-of-Paradise (*Paradisea rubra*, Vieillot) is about as large as the preceding, and in many respects resembles it. The feathers on the head and neck are short and dense. Those around the bill, on the face, and top of the head, including the two crests, are velvety and black, appearing green when viewed in a different direction; those on the throat and front half of the neck are of a bright, deep green; those on the shoulders, upper wing-coverts, back of the neck, and across the upper part of the breast, are of a golden yellow. Lines drawn from the eye to the throat, to the back of the head, and down the sides of the neck, and curved to a point at its lower part in front, would nearly coincide with the limits of the colors. The wings, tail, and belly, are of a deep chocolate-brown; the breast being of a little darker color. From each side below the shoulder proceeds a tuft of loose, plumy feathers, about a foot long, of a beautiful, deep carmine color, slightly tipped with white. From the upper part of the tail arise two black, slender, ribbon-like shafts, about two feet long, and nearly one-fourth of an inch wide, without any web, and toward the end inclining to curl.

The King Bird-of-Paradise (*Cicinnurus regius*, Linnæus), called by the Papuans *Saya*, is about as large as the thrush; but the male bird has a tail so short as to give it a jaunty appearance. It is not fond of tall trees, but keeps mostly among the small bushes, seeking berries and other food. It is a solitary bird, and very beautiful. As it is sometimes found with other species of the same family, and yet keeps somewhat aloof from them, it was formerly supposed to be their

leader. The head, neck, upper part of the breast, the back, wings, and tail, are all of a deep red or maroon color, the head inclining to orange, and the breast to a darker red. The belly is white. Across the chest there is a band of beautiful green feathers, that, in some directions, appear black. From each side beneath the shoulder arises a tuft of broad, truncated, light-gray feathers, or plumes, two or three inches

Fig. 4.

King Bird-of-Paradise (*Cicinnurus regius*).

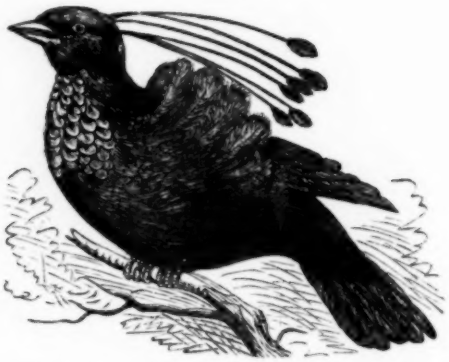
long, tipped with bright metallic green. From the middle of the tail or upper-tail coverts proceed two shafts or filaments, appearing like wires, about one-sixteenth of an inch thick, naked for about six inches, then having a bright, golden-green web on the inner side of each shaft to the end, each of which is there coiled outward in a spiral curve, so as to form a beautiful flat disk; the shaft extending nearly twice round the curve. This peculiarity gives to the bird its generic name, *cicinnurus*, meaning a tail with curled feathers: its supposed leadership gave to it its specific name. Most parts of the bird have an exceedingly brilliant, satin-like gloss. The female is of a dull-brown color above; gray, streaked with black, beneath; tinged with red on the wings; and has a tail about three inches long.

The Gold-breasted Bird-of-Paradise (*Parotia sexpennis*, Vieillot) has three long, slender shafts, or feathers, proceeding from each side of the head near the ear; they being without web, except the part near the outer end. These can be raised or lowered at pleasure, so as to stand out horizontally on each side of the head, or left to hang loosely backward. It has also a small crest. From each side beneath the shoulders arise massive black plumes, with a loose web, like that of ostrich-feathers. The general color of the bird is a deep, velvety black; the head, throat, and back, having a violet gloss; the wings

and tail, black. The neck and breast have scale-like feathers of a brilliant, changeable green, edged with gold.

The Superb Bird-of-Paradise (*Lophorina atra*, Vieillot) is distinguished for its black, velvety scapulary feathers, which are greatly developed so as to form a long, double tuft or plume, which it can raise at pleasure, so as to appear as a very large, double crest, or permit it to fall upon its back and sides. A tuft of feathers, also, hangs

FIG. 5.



GOLD-BREASTED BIRD-OF-PARADISE (*Parotia sexpennis*).

from the breast, which spreads "into a doubly-pointed form, being of the most brilliant steely green, and glittering with gem-like radiance in the sunbeams. The general color of the bird's plumage is the deepest imaginable violet, appearing of a velvety blackness from its very intensity, and only flashing forth in the brighter hues as the light falls upon the edge of each feather. The back, hind neck, and head, are of a greenish-gold color, with a velvety appearance; the wings are a dull, deep black; the tail is black, with a blue gloss; the throat, changeable violet; and the belly, bright golden green."

Wallace's Bird-of-Paradise, or the standard-wing (*Semioptera Wallacei*, Gray) is a little larger than the American robin. The head, neck, back, wings, and tail, are all of a light brown or drab color; the belly, drab streaked or mottled with black. From the short feathers at the bend of each wing arise two white feathers or plumes, about six inches long, which the bird can raise and keep erect, or let fall upon the wing, at its pleasure. But the great beauty of the bird consists in its brilliant double tuft, proceeding from the breast and lower part of the neck, extending downward and obliquely outward, and terminating in two points about four inches apart. This tuft is of a bright, metallic green, changing into blue, violet, or black, according to the direction of the light; it is exquisitely beautiful in itself, and its beauty is increased, if possible, by the striking contrast with the otherwise dull color of the bird. The legs and feet are of a drab-

color. The female is wholly of a drab-color, without tuft or wing-shafts.

The Magnificent Bird-of-Paradise (*Diphyllodes speciosa*, Boddaert) is about as large as a thrush. The head, back, tail, and primary wing-feathers, are dark-brown; the other wing-feathers, yellowish-brown. The breast and belly are of a beautiful purplish green. A circular tuft extends over the hind-neck and shoulders, and is, in the upper part, light yellow, and in the lower parts brown; this double tuft, on account of its resemblance to leaves, gives to the bird its generic name. The tail is about two inches long, and from its upper part arise two thread-like feathers about ten inches in length, each coiled in a circle about three inches in diameter. The shafts of these feathers have, on one side, a narrow web about one-sixteenth of an inch wide, of a beautiful green or violet tint, according to the direction of the light.

FIG. 6.

SUPERB BIRD-OF-PARADISE (*Lophorina atra*).

The Long-tailed Paradise-Bird (*Epimachus magnus*) has a tail more than two feet long. It is sometimes called the Superb Plume-Bird, and, with the next species, is included in the same family as the hoopoes. It is a native of New Guinea, and is a most beautiful and lovely creature. Lesson says: "To add to the singularity of this bird, Nature has placed above and below its wings feathers of an extraordinary form, and such as one does not see in other birds; she seems, moreover, to have pleased herself in painting this being, already so singular, with her most brilliant colors. The head, neck, and belly, are glittering green; the feathers which cover these parts possess the lustre and softness of velvet to the eye and touch; the back is changeable violet; the wings are of the same color, and appear, according to the lights in which they are held, blue, violet, or deep black, always, however, imitating velvet. The tail is composed of

twelve feathers; the two middle feathers are the longest, and the lateral feathers gradually diminish; it is violet or changeable blue above, and black beneath. The feathers which compose it are as wide in proportion as they are long, and shine both above and below with the brilliancy of polished metal. Above the wings, the scapularies are very long and singularly formed; their points being very short

FIG. 7.

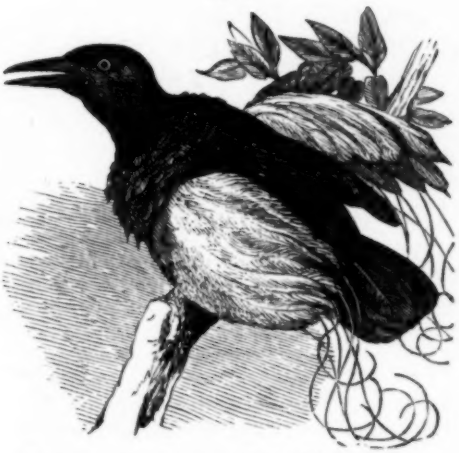
LONG-TAILED PARADISE-BIRD (*Epimachus magnus*).

on one side, and very long on the other. These feathers are of the color of polished steel, changing into blue, terminated by a large spot of brilliant green. From each side beneath the shoulders spring long, curved feathers, directed upward; these are black on the inside, and brilliant green on the outside. The bill and feet are black."

The Twelve-wired Paradise-Bird, sometimes called the Twelve-

thread Epimachus, or Plume-Bird (*Seleucides alba*, Lesson), is a little larger than the jay. It has an elongated body, ample, concave wings, a black beak about two inches, and a tail three inches long; the legs and feet are of a pink-color. it is a native of New Guinea, and is fully as beautiful and lovely as the preceding species. All its plumage has a soft, velvety appearance. The head, neck, and breast, appear black. Across the breast, and on the shoulders, is a circular tuft of black feathers, two or three inches long; those on the sides

FIG. 8.



TWELVE-WIRED PARADISE-BIRD (*Seleucides alba*).

of the neck being, at the end, of a metallic green. The wings are of a rich violet, with a brilliant lustre, in some directions appearing intensely black. From each side beneath the wings proceed a number of silken, snow-white plumes, whose loose, downy vanelets, are gracefully waved by the gentlest breeze. The contrast between the general velvety or lustrous blackness of the bird and the snowy whiteness of these delicate plumes is exceedingly striking, and produces a most pleasing effect. These plumes are about six inches long; and six of the shafts, on each side, are prolonged about ten inches beyond the extremity of the web, and there appear like black threads or wires, giving to the bird its common name. The parts of these shafts which bear the web are pure white, as well as the web. The feathers of the Plume-Birds are taken to Europe, and used as an ornamental part of dress for ladies.

On the upper floor of the old Arsenal Building (which is open to the public the last four days in the week), in Central Park, New York City, there are several prepared specimens of Birds-of-Paradise, including five Great Birds, three Red Birds, four King-Birds, four Wallace's Birds, one Magnificent Bird, and one Twelve-wired Bird. These

specimens will give, to any one who can examine them, a better idea of the size, form, color, and general appearance of the birds; the metallic lustre, change of color, and delicate structure of their plumage, than any words or engravings can convey. They would furnish a definite outline that would much assist and guide the imagination in giving life to their forms, spirit to their actions, and reality to their finer traits of character, as developed in their native islands. But still all lifeless forms fail to come up to the living birds in a state of freedom. And we need not be surprised at the enthusiasm of the amateur, who observes them in all their freshness and beauty, sitting in the aromatic trees, feeding among the bushes, floating in the breeze on their gossamer-like plumes, or glancing through the groves like streaming meteors, in the exhilarating atmosphere of their own genial clime.

THE CHAIN OF SPECIES.

By Hon. LAWRENCE JOHNSON.

Part III.—*The Passage from Annulosa to Mollusca.*

ANOTHER plan, however, is proposed, which seeks to connect Annulosa and Mollusca as successive stages in the progress of evolution from the simplest types and stages necessary to be taken in order to reach the highest development. This is the chain: Evolution of Protozoa directly into Annulosa; or first into the cœlenterate type and these into the annulose, either of which routes seems feasible and easy; then Annulosa into Mollusca; and then Mollusca into Vertebrata. Pursuing this road, the only difficulty of importance is the passage from the articulate or annulose form to the mollusk. Enough has already been said to furnish the key to all the other transitions, and the few brief minutes left us must be devoted to this really obscure problem. If the bridge erected here is practicable, it puts a different aspect upon the whole question, and reflects light backward and forward on every link of the chain.

As remarked, the only real difficulty is to connect annulosa and mollusca. For from cephalopods it is easy to develop the vertebrate type, by elongating the ventral aspect of the creature; and bringing down therewith the ventral portion of the cephalic appendages, which subsequently assume, or rather return to, the place and functions of lateral limbs to the main trunk; the other cephalic appendages, properly belonging to the neurohæmal axis, easily taking the form and offices of œsophagus, branchiæ, and even internal bronchial apparatus. Evolution of *amphioxus*, in this way, from some lost *octopus*, is easier to account for than from *salpidæ*, as proposed by recent authors; even

if amphioxus is a vertebrate animal, which is exceedingly doubtful. But the difficulty is to get to cephalopods.

It is confessedly easy to pass from the cœlenterate type to the annulose—or, in the old style, from *Radiata* to *Articulata*.

Nothing is more manifest in Nature than that she never loses the effect of a habit—never gives up a plan—never resigns the use of means and tools once adopted. When we have arrived at the involute cell as the type of the endothentic series—the animal kingdom—nothing is more obvious than the compounding of the simple form to constitute the rest of the kingdom. Nor is it necessary to suppose that the compounding takes place by any other means than that already observed in the case of exothentic creatures. If vegetal cells multiply and compound by a *gemmating* and fissiparous process, so also does the endothentic and celœnterate type.

Mr. Spencer has shown, triumphantly, how this may take place even mechanically. A simple endothen becomes two by ordinary growth, until division is forced at some median point, exactly as in the case of a cell. When the separation is complete we say this is an increase by gemmation. When there is differentiation without separation, we call it *compounding*—or, as Mr. Spencer has it, an aggregation. The same two great laws of aggregation and segregation, which rule in all things else, present themselves here also in explanation of the phenomena of life. As presented in annulose and annuloid creatures, the compounding is a segmentation. For an annulose or articulate segment is nothing else but one of the simple elements of a compound structure, of which the distinction of the parts is less pronounced. In sponges, in corals, in compound ascidians, the segregation is far advanced—the compounding is very evident. In these it is not denied any more than in the analogous compounding displayed in mosses, ferns, and trees. For, according to the laws of vegetal life already reviewed, every leaf, every node, is a distinct creature, and the bud of the node its progeny. But it is not at first sight so obvious that the real law of all creatures constituted of rings and joints is the law of compound association. It is difficult, without some reflection, to admit that every segment in these is a modification of the original unicellular creature—the mono-segmentarian from which the aggregation sprang. Yet the most casual anatomist cannot fail to perceive that each section in annulosa is but a repetition of the same structure with all its organs and appendages. Even where there are modification and differentiation of function, the structure is always and evidently identical—perfectly homologous.

Fully comprehending the nature of segments, we may proceed to the further efforts of Nature to obtain higher combinations and greater concentrations of energy. For this seems to be the end and object aimed at, if we may be allowed in our own minds to clothe Nature with conscious impersonation, i. e., personality. From the organization

of the first drop of protoplasm, and the vivification of the first cell, the tendency has been, as the necessary result of natural selection, to concentrate force. In the history of evolution there is no passing from lower to higher forms—no foldings, no involutions, without an increase of power; and by the same law this development must continue until the highest point of physical energy is attained.

Our ordinary discoveries teach us that force can be multiplied by a multiplication of the elements or organs evolving force. The simplest child knows how to obtain two pounds instead of one by putting another weight in the scale; and the electrician obtains more power by adding another jar, or another plate, or another cell to his battery. In like manner Nature has in various directions seized every means to increase and concentrate what for convenience is termed *vital force*. For there is the same tendency of the forces to aggregation that we see in matter.

Watching the progress as we have ascended the scale from the first evolution of life, the greatest concentration of force yet reached in organic life is in articulate creatures—or, as we may call them, by a name of more general application, segmentarians. A segmentary such as a centipede, a bee, a lobster, or even the humblest worm, is as truly a compound zoary as any other collection of zooids, whether cœlenterate or molluscoid; and no argument is needed to show a physicist that the closely-united segmentarian zoary evolves more force than the looser aggregation of a branch of ascidians, however highly organized the individuals of the latter may be. There is more force evolved from the gigantic oak consisting of such a closely-united system as presented by the nodes, and which is capable of appropriating such volumes of inorganic matter, than in the loose sheets of *ulva* or *protococcus* creeping upon damp walls and slimy pools. Again, in physics, we may multiply force, not only by the number of our elements, but by their size and arrangement. In galvanism two large elements or cells may be made to exhibit greater energy than many small ones in the aggregate of equal superficial extent, yet not precisely the same energy. It is modified as well as increased. Organic Nature presents us exactly as good illustrations of this law as the experiments of Mr. Grove and Dr. Faraday.

The first experiment, so to speak, of Nature to multiply force from the cœlenterate or monosegmental creature, the last stage arrived at in our progress, is by multiplying the segments upon one or more axes. When upon more than one, as in annuloida, Nature seems to break down early, on account of the complication of the machinery, and soon seeks greater simplicity. This is attained, first, by selecting one longitudinal axis, and multiplying the units or elements of organization and force indefinitely. In some worms the number of segments is incredible. Instances of iulidæ, according to Mr. Newport, have one hundred and fifty rings, at least during embryonic life; and, by the

same rule, some geophilidæ, mentioned by Dr. Carpenter, must reach to three hundred and twenty — each segment, remember, having a *quasi*-separate organization, separate circulation, separate nerves, and separate appendages for aëration and locomotion. Their close and intimate connection does not prevent easy analysis into distinct systems for each segment.

Again, however, Nature soon discovers her mistake. The highest concentration of energy cannot be reached in this way, and she makes trial of a new plan. She seeks to modify and expand the elements, and to bring them into closer contiguity. Gathering up her forces into a few central segments, the rest are lopped off. This is actually the history seen in some embryones. In insects, finally, the highest of the segmentarians, there are only about twenty well-pronounced segments. Some of these, as in the cephalic and thoracic regions, are so intimately united that the divisions cannot be traced, except in the embryo. In adults the thoracic segments are further modified, for great extension and concentration of force, by expansions, primarily, of the aërating apparatus into legs, wings, or other appendages. In short, the thoracic region is evidently the concentration of the life of these creatures.

Now to advance beyond this type. Nature never changes her tools —her means; and even her plans present but slight modifications. Her collection and concentration of energy in the thoracic region of polysegmental annulosa is a gathering of her strength at that point whence the next march will begin.

Exactly as we may see an individual segmentarian zoary doubling itself up for its own comfort, increase of heat, or of force—exactly as we have seen in vegetal life, after a longitudinal or a superficial evolution of the elements of the compound, energy concentrated by a folding down of the compound upon itself, and an adhesion—so works Nature here. The concentration of life or force at any one point diminishes its intensity in remoter segments; a more intimate union of a few segments causes atrophy in the more distant frontier provinces; and this process continues, in fact, until the segments are reduced to two. The very fact of a closer folding and adhesion of two would have this result. This is a position we might, at this stage, comprehend *a priori*. Now let us see if it has any foundation in fact.

Again I repeat, this is not an imaginary process I am going to amuse you with—it is not speculation—but an irrefragable chain of facts and demonstrations. The *entomostracous* group of *crustacea* affords us illustrations of every step of the progress. First, an excessive development of two segments of the thorax; then, atrophy or dwarfing of the cephalic and abdominal regions, in various degrees. In cypris, for instance, two segments are so enormously developed as to usurp the mass of its substance, if not yet all the functions of its life. The dorsal scales of these two segments are actually so enlarged as to present

a bivalve box, or case, to inclose the creature as snugly as you see effected for a clam or an oyster. Loss of head and tail would leave the little cypris as perfectly a testacean mollusk as any of these.

But you say, if—if it should lose head and tail! The exaggerated fable of the fairy tale is actually the method adopted by the magician Nature to disenchant the fair princess Life from the thraldom of larval and infusorial forms. The cypris does lose head and tail, and so becomes molluscan, before proceeding to higher evolution. But not as a cypris—oh, no! she changes her name, as she changes her type; and we must advance to another group of the entomostracous class—one which has been divided from it, more on account of general superior size than for any other reason—the *cirrhipeds*.

In this group we find the most striking metamorphoses in the life of the same individual. Passed out of the mere embryo, the larval form resembles more an ordinary macrourous decapod than the entomostracous its nearest relations. Take one generally known, the genus *lepas*—the common goose-barnacle—in extreme youth, an exceedingly active little shrimp-like tenant of the deep. During the latter part of this stage, the hypertrophied segments of the thorax continuing to grow as the cephalic and abdominal parts dwindle, finally, by his jaws, he first seizes hold of some solid support, when the whole head and neck become entirely changed, and remain a mere stipe, for the support of the creature. Every part becomes metamorphosed. The head having disappeared, a new mouth is opened in the breast; and the abdominal portions, although not entirely lost in this genus, are differentiated to other functions. The most important change to notice, in this creature of change, is the change of axis. It is now exactly at right angles to the original axis of vitality in the young crustacean. Yet, mark well: this is only a return to the true axis of nerve-force in the segments, which, in all *annulosa*, is at right angles to the longitudinal development of the sections. The interminable gemmations and addition of segments to the zoary being arrested, and life confined to one or two, most naturally the current of the dominant force remaining controls the direction or axis of all the rest. So completely have the method of vitality and the appearances of the little animal been changed, that earlier naturalists classed the young *lepas* as a crustacean, and the adult barnacle as a multivalve mollusk. And so, indeed, it is a mollusk, with a few crustacean characteristics not yet lost.

The steps from this to the perfect mollusk are too plain to be dwelt on here. Indeed, the difference is so small that, had not the larval cirrhiped been discovered, the position of the group would never have been assailed. They should, like human aspirants to rank, have concealed their plebeian origin. If the observations of recent embryologists are to be credited, many mollusks and molluscoidea exhibit a similar evolution. At any rate, even in undoubted mollusca, the elements of their segmentarian origin are abundantly visible.

If we take the genus *arca*, for instance, as a typical mollusk, it is easy to follow the segments of which it is composed. Each half of this bivalve has its own organization, as complete as in any segment of any annulosa. Each has its own heart, its own nerve-ganglia and branches, its own aërating apparatus and systemic circulation, such as it is. You may even trace, still, the crossing of muscles and nerve-fibres, at the back or hinge, exactly as between the two articulate segments from which they sprang.

Here it may be remarked, again, how tenacious Nature is of her plans. This mysterious crossing and anastomosing of nerve-fibres, so unaccountable in the brain of the higher animals, and of such important consequences even in man himself, had its origin in the primal union of two *annulose segments*.

Having overcome the principal difficulty by noticing the change of axis, nothing more remains but to pursue this bisegmental arrangement to its full development in the grand class of mollusks. Possibly not one of existing species had any part in the chain of development. But this is of small interest at present, since we are looking for the method, the steps, the finger-boards of the road traveled, and care not now to count the milestones.

The transition from the highest mollusca to vertebrata, as already remarked, is plain enough. Mollusca already have the internal structure of vertebrata — the same digestive system — similar nerves — and identical circulatory machinery. The highest mollusks have as much brain as the lowest fishes, and decidedly more than the famous amphioxus—a creature which just now is an obstruction instead of a help in the establishment of a sound biological theory of development; and this for the reason that it is leading us away from the true relations of these orders, and helping to keep up the old misconception of the nature, origin, and importance of a jointed spinal column. Unfortunately, it is this want of vertebræ, of backbone in mollusks, that prevents us from seeing the near alliance of cephalopods to vertebrates. Had the latter been supplied with the more appropriate and distinctive title *Cerebrata*, these highest mollusks might better have claimed admission to the class than many species now found in its ranks. For, besides the homologues already mentioned, do but notice the optic and auditory apparatus of sepia, for instance. These are perfectly identical with the eyes and ears of vertebrates. Notice, again, the organization of the mouth. Only vertebrates have such. In annulosa the jaws have lateral motion, and are modifications of the feet. One other consideration must be mentioned—the size of these animals. Only vertebrata and mollusca seem to have unlimited powers of increase. They only have been distinguished for the magnitude of individuals. Among the latter especially are to be noted the cephalopods for furnishing giants. Did space permit, a thousand homologues might be pointed out.

From all of which results the general conclusion, worked out more fully in my paper on the "Homologues of Organic Creatures," that here is the true route of organic development; the vertebrates from the mollusks, and these from the articulates proceed; and that the basis of the history we are seeking must be searched for in the history of *segmentation.*

All are familiar with the construction of an annulose ring or segment. To the rest of the compound creature each segment is a microcosm, precisly repeating similar parts, or their homologues. To each segment belongs a neural ganglion, or rather a pair of ganglia; a dorsal vessel swelling in the middle to a pulsating organ, or heart, or rudiments thereof; and each is furnished with stigmata, spiracles, or appendages, which are homologous of each other, or, as before, with rudiments thereof. And all these by sufficient analysis are to be traced as actually present in every true segment, however often the function of the homologous structure may be changed, or however it may be reduced to a rudiment, or atrophied, or absorbed and apparently lost. These homologues constitute the basis of biology, as they do of the life-functions of all creatures made of segments, which includes, as we have seen, mollusks and vertebrates, as well as annulosa —possibly, also, molluscoidea; unless the latter should be considered a modified cœlenterate, and then it would be the beginning and unit of the series. If, as sometimes contended (and these are unsettled questions), the molluscoid is an evolution of the annulose type, and its embryonic history tends to prove this, then all the segments have been lost but one. For the molluscoids are monosegmental. Nor is this proposition strange or improbable. Undoubtedly such a reduction to one segment takes place in high orders of genuine mollusks, as in gasteropods (of which you have instances in common snails), in whom one segment has become atrophied, leaving generally a rudiment behind.

In vertebrata, which more immediately concern us, two segments, and only two, are always present, and always bear with them their distinctive elements or appendages, however rudimentary some of the latter may sometimes appear. These segments really constitute the well-known bilateral arrangement of parts and organs so general in animals of this class. Here, again, it is necessary to go back a little in order that we may make the greater speed forward. It is necessary distinctly to understand what we are talking about, and what we mean by segments. In the discussion of the bisegmental organization of vertebrates, the question comes up whether any true homologues exist in the two great classes, vertebrata and annulosa. In the present advanced condition of biology, this question receives a decided affirmative. Until recently the contrary was generally supposed.

When it is seen that two sides of a vertebrate, if it be split asunder down the backbone, present exact counterparts of each other,

and also of two segments of any annulose animal—a crustacean or a centipede, for instance; and when we have seen in the progress from unicellular and from monosegmental structures, to the multi-segmental; and from these again to the bisegmental, by lopping off surplus machinery, and by modifying and enlarging what is left in order to increase and intensify the forces evolved; when we actually see these changes, with the attendant change of axis, taking place and becoming the normal conditions of some creatures—all mystery vanishes.

First, let us notice that the so-called vertebrate segments or sections—the vertebræ of the spinal column, are not segments in the sense used here—are not *segmenta*, the biological bracelets, in any true sense; although their development takes place after the change of axis by a growth analogous to the original evolution of annulose segments. The vertebræ are not homologues of the segments of the great segmentarian series.

Having thus indicated what the segments are not, let us call to mind again what they are. This will be the best way to establish the chain we are seeking to comprehend, as it will also be the readiest plan of exhibiting the homologues of these classes, upon which depends all our knowledge of transcendental biology. It is best done, in the few moments left us, by tracing a few of these homologues. For this purpose let us select prominent and obvious organs, for instance, the heart, the brain, and the extremities or appendages.

The first to be noted, being most obvious to popular inquiry, are the extremities or limbs—the true articulæ. Fins, wings, legs, and arms—can these truly be homologues of the arthritic appendages of annulosa? They are indeed. Not half so plain, when first announced, was that first wonderful revelation of comparative anatomy, which displayed the fin of a fish, the paddle of a whale, the wing of a bird, the leg of a horse, and the arm of a man, to be composed of the same organic elements, as is this which now proclaims that these so varied and beauteous limbs of vertebrate animals made the first essays of their evolution as the lateral appendages of aëration or locomotion of the segments of the lowest orders of *annulosa*.

The proofs of this are now obvious, but to appreciate them we have need to travel back again through all the grades of life, and weigh the homologues of every organic element.

Yet some of the evidences are plain, and almost superficial, in the vertebrate class itself. Every anatomist, in order to comprehend the physiology and anatomy of this class, begins his analysis of the vertebrate skeleton by observing two distinct systems of organization—the *dermal* and the *neurohæmal*, heretofore supposed to be peculiar to vertebrates. Now, to which system, the dermal or the neurohæmal, do the extremities belong? No amount of ingenuity can satisfy the thoughtful student that the limbs are evolutions of the appendages of the neurohæmal axis. They are dermal. Even in *mammalia* they

have no proper union, no true articulation with the spinal column. Even in those cases where the bones of the pelvis and of the sternum are most securely fastened to the neural axis, it is by a mere anchylosis completed only in the adult age.

The dermal system is the counterpart and homologue of that wondrous external skeleton of articulata, as you must see if you have followed me through the metamorphoses of cœlenterata, entomostraca, and cirrhipeda to mollusca, and from mollusca to vertebrata. Comparative anatomy will not hesitate now to point out every correspondence of every part, every organ, every articulation. Not a bone, nor a scale, nor a hair, is ever lost. In each limb there are so many joints and no more; and with a certain definite relation to each other, clear and true; to be seen in the contorted limbs of articulata, as well as in the arm of man.

Our very limited amount of time compels me to make this address a mere introduction to the subject; compels us to be content with mere *suggestions* for *studies* in biology, to be pursued by after-investigations.

One of these suggestions is made to us by the manner of the *folding* of vertebrate limbs. The difficulties of the question, as put by Dr. Wyman, for example, are well worth consideration, and by this transcendental history of evolution find solution. How is it that in all vertebrates the forward limbs fold one way, forward, and the hinder limbs the reverse? But take you any two segments of an articulate creature, a crab or a grasshopper, and observe how the appendages extend away from the body, and the mystery is explained. For the effect of the magnetic and other forces causing polarity or arrangement is to be searched for and found first in the segments, always remembering that in articulates the axis of the neural system—the life of each segment—is transverse to the general axis of the compound organism. Now, separate two such segments of your articulate—fold them together in the manner indicated by the history of *cypris* and of *lepas*—revolve the involuted creature ninety degrees, stretch the limbs forward and backward as their organization fits them to move; and you cannot fail to perceive a perfect counterpart of the motions of vertebrate extremities.

But this is not half the demonstration. Indeed, it is now so well settled, that Science can, dare make one of those *predictions* always regarded as affording by their verification the highest order of certainty. After noticing the remarkable fact that all vertebrates having limbs have four, or the rudiments of them, and no more, Science predicts with the repose of conscious systematic truth, derived from this doctrine of segmental genesis, that no vertebrate animal, nor the remains of any, ever will be found, on the earth, or in the waters under the earth, or in its caverns or quarries, having more than these *four* homologous appendages—and these always dermal.

But, it may be objected, this is only of external matters, the limbs, the appendages; and these may be accidental correspondences.

Very well! Select any other set of organs. Are there any more internal and peculiar to vertebrates than the brain and nerves? Let us take the neurohæmal system itself, that which confessedly has no perfect counterpart in the articulate class. It is not suggested that any creature lower than cephalopod mollusks presents any thing exactly corresponding to the cerebral hemispheres, and the optic and auditory lobes of the vertebrate brain. But let us see if we cannot trace some homologues? Without this historical derivation from annulose segments there will remain many things in cerebral anatomy entirely inexplicable. To pursue this theme no further at present, the approximation of the vertebrate and the molluscan systems of nerves cannot be doubted. In higher cephalopods, as sepia, the principal ganglia are brought into near proximity—at least resembling a brain. They are even covered by a bony framework, rudimentary of a neural skeleton—in all of which the great cephalopod is decidedly more cerebrate than some fishes, to say nothing of the doubtful amphioxus. But if all else were wanting, the auditory lobes and the optical apparatus would establish this correspondence with the highest orders. The cuttle-fish has an eye with a retina, lens, iris, and cornea; and the optical ganglia are as truly lobes of the brain as they are in mammalia. Nothing like this is seen in acephalous mollusks, nor in articulata. Where articulata have a machinery for vision, it is not organized upon this plan. But we do see centres of nerve-force, or ganglia, appertaining to every segment; and we do see also that the nervous system of sepia is only an advance upon that of the inferior mollusca. Even in the oyster the ganglia are brought nearly to a common centre; and this arrangement does not differ essentially from that in the perfectly equilateral mollusks, as in arca, for instance, except in the nearer contiguity of the ganglia. Finally, comparing arca with lepas and cypris, it is manifest that we have essentially the same plan as in the nervous system of any two segments of articulata. For you will find in each segment two ganglia, one on each side of the median line; and these being brought together, as they generally are in annulosa, appear as one. Now, this one twofold ganglion is, if our explanation of the metamorphoses of the segments be correct, the homologue of the ganglia of muscular motion, of the two principal valves of cypridæ, of cirrhipeds, and of bivalve mollusca; and finds its final evolution in the quadruple structure of a mammalian brain. In fact, the homology is complete, with the additions, or rather modifications, already explained, which endow vertebrates with olfactory, auditory, and optic lobes and systems apparently peculiar.

There is another branch of the internal structure of vertebrates inexplicable upon any other hypothesis than this chain of specific descent. I mean the hæmal system—the system appropriated to the circulation

of the blood. Comparative physiology, guided by the light of this metamorphosis of the segments, can have no difficulty in tracing the history of the heart back from mammals, and reptiles, and typical mollusks, to crustacea; and finding it at last reduced to its elementary form in the twofold pulsatile vesicle of the dorsal artery of each double segment of, for instance, iulidæ—lowest of the annulose series. The folding together and stricter union of these segments, as we have seen, bringing these pulsatile vesicles into juxtaposition, perfectly account for the two double hearts of bivalve mollusca, and of fishes; while the approximation and union on the median line of this double machinery of the mollusk explain the fourfold heart and the circulation of the highest types of life.

If you have followed the chain of evolution here briefly sketched, although in mere suggestions, you can have no difficulty in perceiving the unbroken succession of allied links, all the way from the lowest cell-formations up to man. Many forms, doubtless, belong to subordinate systems, and take no part, directly, in the chain; yet the study of all will enable us more fully to comprehend the whole process. In fact, we have no right to expect to find, unless perhaps in fossil forms, the precise *species*—the very *links* of the chain—by which the transmission of *form* and *life* has been actually effected. It would be unreasonable to require this of the advocates of evolution, since the exact contrary would follow, as an *a priori* conclusion, from the very terms of the proposition. It would be a wonder, indeed, in view of all the transitions and transmutations of matter, of force, of time, of place, of forms, if we could find, now living, a single species actually concerned in the long process of evolution—a single "bark which brought us hither." It is just as unreasonable as to demand of us to produce, alive, every individual through whom our descent has been accomplished—just as unreasonable as to demand the resurrection of all the members of our race, for the last thousand years, to prove ourselves Anglo-Saxons. Time necessarily devoured these when the period of life was finished. So has it done with *species;* for, as the species is continued through individuals, *and always with variation*, the distance of removal from any special form is only a question of time. The cosmos is always

"Ein wechselnd Weben,
Ein glühend Leben,"

and, therefore, it takes but a few generations—a few thousands, or a few millions of years—to leave behind any specific type, as completely as the forgotten bones of our progenitors that lie hid in Batavian bogs. Why, with all the lights of human history, we cannot trace the line of any human family more than a few hundred years! And what is the historic period, upon which all doubts and objections are based, compared to the ages multitudinous that have passed away without recognition in human calendars? Take the simplest tree, a few years old. We see a crowning bud at the apex of its principal axis of

growth; and we see long lateral branches, likewise, similarly tipped with leaf, bud, and bloom; and we do not doubt their common origin, because there stands the common connecting trunk. Yet neither of these had any part in the production of the others; nor remains there a single one of the individual buds and tender leaves which, in the years gone by, really did take part in the development, the consummation whereof we now behold.

Nor, in regarding man, whom we fondly believe the crowning glory of creation, should we expect to see the precise yearly growths which have finally lifted him to this elevation. The steps of the evolution may still be traced, but not a single individual of the lineal ancestry remains. When, therefore, we speak of the chain of species—of the line of man's descent—upon *a priori* grounds, we do not expect to find, extant in life, the very links of the chain. The loss of them is another proof of evolution. It is thus, according to the plan proposed, we would expect to find it exemplified. It is a rational conception of creation we are attempting to reach, and no other rational hypothesis has ever been proposed.

We do not find, then, the very species through which the ascent to man has been accomplished, and do not seek to find them; but, if this plan of derivation is well founded, as it is clearly rational, we must conclude that the various races of man, now upon the earth, sprang from some common stock, of the order of primates; which, in turn, must have been derived from a lower simian form; and this, again, must have come of a trunk leading back to aplacental mammals; and these lead on to amphibious reptiles; these to fishes; these to cephalopod mollusks; these to bivalve mollusks; these to cirrhiped crustaceæ; which last, in fœtal life, possess all the characteristics of the general articulate or annulose type; annulosa being derived directly from primordial cœlenterata, whence probably issued, also, annuloids and molluscoids. If molluscoidea be the offspring of cœlenterata, then the part played in evolution by the molluscoid type was not to furnish a stage of transition, but to illustrate the power of a segment. In any case, we end with the cœlenterate type, whether fixed, as in actinia, or *occasional* only, as in rhizopods. This last, being the first animal form, causes us to remember that here branches off another great kingdom, of which the life is always exothentic; and which, therefore, has no direct part in this chain, except that its first forms furnish the common stock whence has arisen all organic life.

This wonderfully intimate relationship of the innumerable forms of living creatures, properly considered, is calculated to elevate our conception of the creation, and of man himself; while, to the glory of the Creator, it is held out to us as another "bow of promise"—another assurance of the certainty of the universal reign of law. Nor must it be forgotten that it does not exclude, but, contrariwise, encourages, moral reflections. While it tells man of his dignity, it tells him

also of his debasement—that he is sublime in being possessed of so much of his Maker's image as enables him to contemplate all this glorious mechanism; but that he is also "a brother to the insensible clod, which the rude swain turns with his share, and treads upon." It also enforces the reflection of the old poet:

". . . . Except above himself he can
Erect himself, how mean a thing is man!"

THE ZUNI INDIANS OF NEW MEXICO.

By FRANCIS KLETT.

ANOTHER interesting branch of the aborigines of North America is that of the Zuni, a thriving tribe, inhabiting a remote section of the Western United States. This people belongs to the Pueblos, a semi-civilized remnant of the Aztec Empire. Their home is in an uninviting portion of the desert district of New Mexico, about 200 miles southeast of the Moquis settlements.

Leaving Fort Wingate, our route lay southwest across a luxuriant, well-timbered spur of the Zuni Mountain, and thence along the Rio Zuni, which was dry, excepting in spots. Passing Ojo de Pescado, a summer retreat of the Zuni, after a weary march through scorching sands, we came, on July 22d, to the suburbs of Zuni town, the outline of whose houses could be traced at a distance of more than a mile; even the characteristic ladder, extending far above the roof, being distinctly visible. As we approached, single dwellings here and there came into view, situated amid corn and water-melon fields. On coming nearer, an old church stood prominently forth, its two well-preserved bells hanging in an opening in the wall over the entrance.

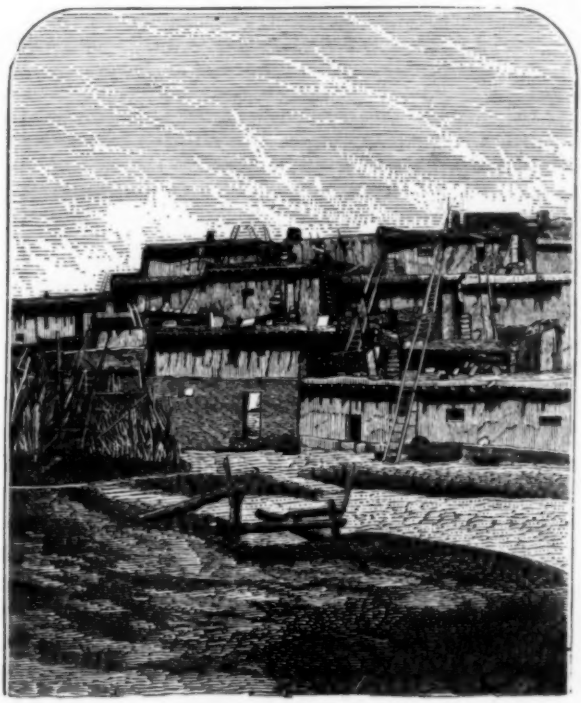
Unlike the Moquis, whose settlements are on lofty rocks, the Zuni town is located on a slight rise above the level of the surrounding plain. Its area is about half a square mile, with streets running here and there at right angles. Much rubbish and *débris* are encountered in entering the town. The houses are of *adobe*, terraced, well built, and principally of two—though some are of three, and not a few of even four—stories. As a means of entrance, ladders are used; although in a few cases there are ground-doors (*see* engraving), still the usual method of ingress is by ladder to the second story, thence inside by steps up and down. Some of the dwellings have isinglass windows, while the doors generally are hung on hinges. Each floor is divided into several apartments.

On arriving at the town, our guide, Swzano, a Zuni, insisted on our first visit being made to himself. Climbing to the second story of his house by ladder, we scrambled in after a fashion, and were wel-

comed by himself and wife, who at once seated us comfortably on sheep-skin rugs spread on the bare earthen floor; bread and water were forthwith handed us, these constituting the simple but recognized symbol of great hospitality among this people.

After a pleasant hour in the company of our guide and his wife, we sallied forth to see the town. Coming to one of the larger houses, we gained ready admission, and were hospitably received. Our presence, however, was the occasion of much comment among the women, of whom we found six in one room. Their peculiar chattering, accompanied by hearty laughter and strange gesticulation, though unintelligible to us, was construed into joking at our expense. The men were in the field at work, while the children were enjoying a bath in the

FIG. 1.

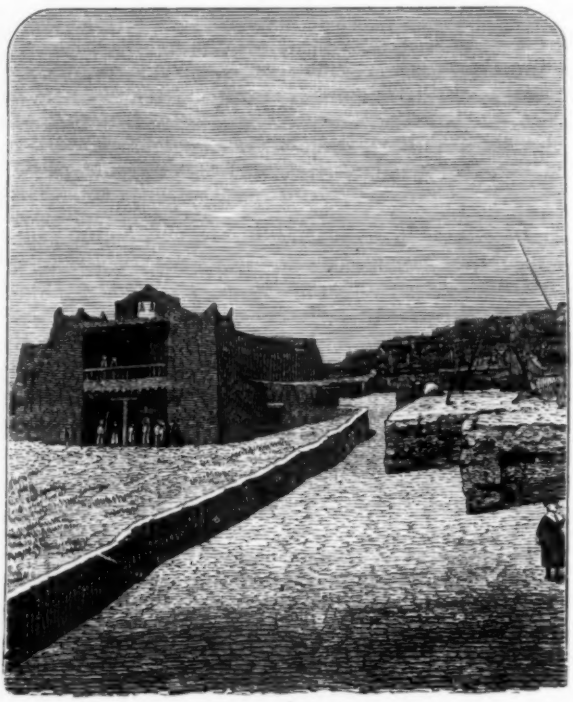


PUEBLO OF ZUNI.

muddy waters of the Rio Zuni. The women were engaged in grinding corn and wheat, an operation effected by means of several pairs of large, flat stones, some of coarse and others of fine material. Between the first set of stones the grain is merely mashed, each successive pair rendering the particles smaller and smaller, the last turning out fine flour. Two other women, in another room, were engaged in baking bread, which is made into thin cakes, or wafers, similar to the

marros of the Jews, only the latter are the harder. On inspecting the house, we found each apartment whitewashed, both walls and ceiling, well ventilated, and in every respect neat and clean; exceeding good order seemed to prevail in the domestic appointments throughout the establishment. The furniture consisted of but few articles, these being principally sheep-skins, Navajo blankets, and water-vessels, the latter used also for cooking-purposes. These vessels are of their own manufacture, of burnt earth, and, in many instances, highly embellished with fanciful designs of neat pattern, the figures being either brown or black, on a ground-work of white. No beds are seen in the house, blankets alone serving as such; the occasional bird-skin, hanging by a string in some corner, serves as a charm. Live eagles and sparrow-hawks, tamed by these people, are seen about almost every house,

FIG. 2.



CATHOLIC CHURCH AT ZUNI.

great veneration being had for these members of the feathered tribe, which are considered the sacred birds of Montezuma. Each dwelling is provided with a loom, which forms a conspicuous part of the furniture. It consists of two sticks, between which the threads, of the width of the blanket to be made, are spread, the whole arrangement being fastened to the floor and ceiling by raw-hide strings. The op-

erator squats on the ground, using for a shuttle a stick to which the wool for the cross-threads is fastened. The operation of weaving is skillfully performed, although a long time is required in the manufacture of one of their blankets.

The domestic animals of the Zuni are goats, fowl of all kinds, a few head of cattle and donkeys—every family owning several of the latter, which, while serving for transporting wood great distances, as well as for riding, are used chiefly in cultivating the fields. One specimen among the goats had four horns, as shown in the engraving, and was said to belong to the species formerly common among the Navajos, called *cimeron*. The sheep are raised for their wool.

FIG. 3.

HEAD OF FOUR-HORNED SHEEP.

Outside the town there is a large farm, of which a sketch is presented. It is cultivated in common by the Zuni, although divided into patches, or small gardens, one of which belongs to each family. No rains occurring for long periods, irrigation is resorted to, the water being supplied by the Rio Zuni, in the vicinity of the town; this water is salty. For drinking-purposes, wells are sunk at different points, good water being everywhere abundant at a moderate depth. The staple products are wheat and corn; vegetables are raised in abundance, chiefly onions, *chile* (Spanish pepper), and caraway. From *close* conversation with the people, however, one would suppose their partiality for the first-mentioned vegetable predominated. Melons and pumpkins are also considerably cultivated.

Sauntering about the village, several underground courts were encountered, as well as subterranean passages from one square to another, and to the old Catholic church. This church is of *adobe*, and at least 200 years old; it is 120 feet long, 40 feet wide, and, within, 130 feet in height. The altar is covered with a profusion of carving, which still shows in traces gilding and colors; it has a painted altar-piece of rude construction, representing the ascension of the Virgin Mary; here and there are carved statues of saints, while on the walls are two illegible inscriptions in Latin. In this church, we were told, a zealous priest celebrated the rites of the Romish Church for a brief period; but no *Gloria* or *Te Deum* has been heard within its wall for upward of a hundred years.

The Zuni authorities are a governor and high priest; the latter is

called the *cacique*, who, besides being the oracle of the tribe, is their temporal as well as spiritual ruler. No outward personification of their Divine Being is made use of; but, entering their *estufas* (temples) with a *bueno corazon* (good heart), they simply pray for some blessing, looking to no visible object as a medium of intercession between themselves and their God. Although for a time they outwardly observed the religious teachings of their conquerors, inwardly they maintained the belief of their race in the infallibility of their traditions, and soon repudiated the creed pressed upon them, returning to the worship of the source of light—the sun—as their only true God. But not only here were the Jesuits expelled; they were also driven out from the pueblos of Jemez, Acoma, and Saguna, as the ruins of the churches testify. However, at a few points the Jesuits still hold sway, as, for instance, with the Isletta Pueblos on the Rio Grande, while with the Mexicans of New Mexico the Jesuits are everywhere in full power. In times of great drought, and during festivals, the cacique orders the celebration of the *cachina*, a sacred dance. Fortunately, it being a holiday with them at the time of our visit, the rare opportunity was afforded us of witnessing this unique, interesting, and most beautiful though heathenish custom, of which a sketch was made on the spot. Some twenty-seven persons were engaged in the ceremony. When first seen, the participants were standing in a row, their faces toward the sun; they were gayly dressed, as will be evident from the description of the three styles of costume worn on the occasion, and represented in the engraving.

No. I. represents a dancer—costume, light-blue mask, horse-hair beard, necklace of black wool and beads, wreath of hemlock as a waistband; short white skirt, with fancy border, held at the waist by a green and black sash, to which was attached a bunch of long, white strings, hanging to the ground along the left leg; a land-turtle's shell, pendent from the left garter below the knee, contained pebbles which served a purpose similar to the castanet of the Spanish dancer; hemlock around the ankles, yellow eagle-feathers in the hair, and a fox-skin suspended from the waistband, complete the make-up.

No. II. represents the captain, who was attired thus: Yellow eagle-plumes in the hair; blue tunic, white under-garment, with fancy side-piece inserted, and blue stockings; in one hand a staff was carried, the other holding a vessel containing flour.

No. III. represents a female dancer (character taken by male); costume, a white *serape*, with black border interwoven with fancy colors, and a blue gown; otherwise, the attire was that of No. I.

The male dancers stand in a row, the female (males assuming the character) facing them and chanting a low, solemn strain, keeping time with the right foot. In the intervals between the songs, the leader scatters flour to the four winds to appease the anger of their Divine Being, and induce him to send water from heaven. December

is the period of their greatest festivity and rejoicing. During this month their God sends his two sons, one to visit the living, the other the dead, of this "his chosen people." Their *estufas* are also used as halls for public meetings.

FIG. 4.

CACHINA DANCERS.

The executive authority of the Zuni is vested in an officer styled governor—one Pedro Pino—who, however, is but the mouth-piece of the spiritual ruler, the cacique; the orders of the latter are the laws governing the tribe, their execution simply resting with the governor. In conversation, Pedro Pino informed us that he was the ruler of the country between the Neutrias and Colorado Chiquito, some sixty miles, and Agua Fria and the Moquis settlements, about one hundred miles apart. In appearance, he is perhaps sixty years old, of commanding presence and affable manners; his hair is snow-white. He told us he had been governor of the Zuni people for many years, and that the tribe had always been friendly to the whites (Americans), from many of whom he had testimonials to the latter effect. Ordering his son, Patrizio, to bring him certain papers, he produced letters from officers of our army and private citizens, which referred to the governor in the highest terms, and also spoke of the uniform kindness in their treatment of his people.

"The Americans," continued the governor, "treat us well, but the Mexicans very badly; the latter have always maltreated us, and we want them neither to go through our country nor to reside among us. The heavens punish us by long drought for allowing them to remain on the Colorado Chiquito. My cacique, who prays for rain, and who is the spiritual and temporal ruler of this people, watches the sun daily, and is much distressed because no rain falls. He (the cacique) attributes the drought to the presence of the Mexican on our soil."

Pedro Pino bade us tell the Great Father that he wanted a "perpetual title to the Zuni country, which," he said, "had been handed down to us by our forefathers, through all time." Further, he remarked: "We are peaceable, and do not make war; if we have a title to our lands from the Great Father, we can show the document, and even the Mexican will respect it." The cacique, who was present, nodded assent, but did not join in the conversation.

The governor very cheerfully and politely accompanied us through the village. As the *cachina* dancers came in sight, and we halted to witness the ceremony, an elderly man approached and remonstrated with the governor for allowing us to look upon this form of worship. In reply to the remonstrance, Pedro Pino informed the intruder that he would allow us, "but," said he, "no Mexican shall ever look upon the performance of this holy and sacred rite. The Americans," he continued, "have ever been our friends, and are good and excellent people. I have been in Washington, and have seen such men as Monroe and Calhoun, and have been in the halls of Congress. These men" (pointing to us) "come from Washington, and I know they are good men." To the last remark *we* bowed assent.

On returning with the governor, we were most cordially welcomed to his house, and, entering, were very agreeably and hospitably entertained. A pipe "all round," and Pedro Pino entered into conversation. He spoke of a single Mexican at Ojo de Benado, and another at the Colorado Chiquito, who were a sore grievance to his people. He said: "The cacique of my nation is very sorry on this account, and the rain will not fall while these wicked men inhabit our territory. I will deem it a special favor if you will intercede with the Great Father for a title for us to our country: this will satisfy us. You men are good, have seen the sacred dance of the *cachina*, and we shall have rain." It may be a fact of importance to the superstitious to know that it *did* rain that evening, and most heavily, the storm lasting several hours!

The traditions of the Zuni are few and simple. They say their people came from the northwest on their march southward; that all Pueblo Indians belong to a common race, and are all members of the large families called Aztecs, or Montezumas; that some of their forefathers remained behind in the great migration of the nation, while the large body pursued a southerly course, ultimately forming the mighty empire of Mexico, as found by Cortez after its conquest; that, long before the white man came, their people inhabited the *mesa* south of their town. They have traditions, also, of a flood; of the founding of their present *pueblo*;[1] of their war with the Spaniards, and their subjugation, by the latter, for a time; of the arrival of the first American in New Mexico, and of the Mexican and Navajo War. But their knowledge of these events is merely outline, they being unable to give any details.

[1] Used for "town" as well as "people."

The Zuni language is much like that of other Pueblo Indians, but the words are, apparently, rather indefinite, requiring much facial contortion and bodily gesticulation to make their sentences perfectly intelligible. They have no schools. Their hieroglyphical writings may be seen in many places, while all along the Cañons de Choca and de Chelle are traces of the ancient march of this people. At Mesa Pintada (Painted Rock), about 100 miles to the northward, we copied one of their hieroglyphical inscriptions, as seen in the engraving. This writing being in the Navajo region, is believed by some to be the

FIG. 5.

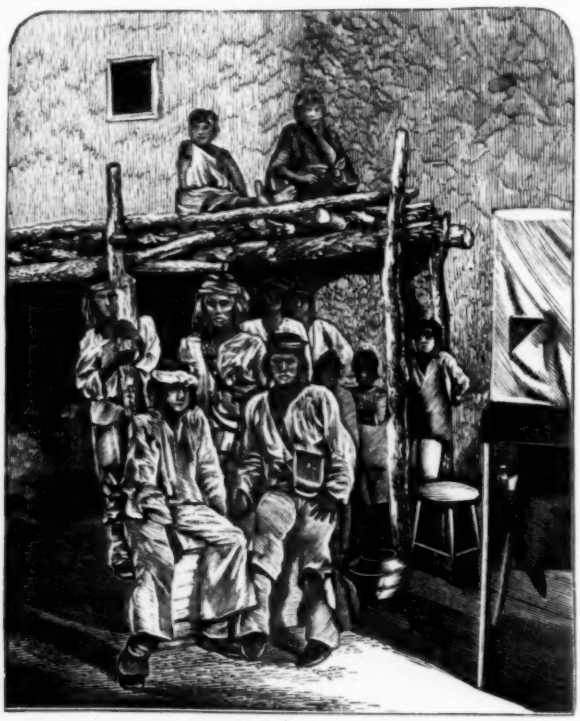
ZUNI VEGETABLE-GARDENS.

work of that tribe; but this could hardly be, since the Navajoes are a nomadic people, and, besides, are not known to possess hieroglyphical writings. The Mesa Pintada is a vertical wall of sandstone, about 150 feet high. The inscription, as here given, was copied on the spot, and is a faithful representation. Commencing at *a*, the writing runs, with the mesa, westward; the space from *a* to *e* is 16 feet; the figures are reduced to one-fifth their original size.

There are many ruins of stone-houses in the vicinity of Zuni, at Agua Fria, El Moro, Ojo de Benado, and Old Zuni, which were undoubtedly towns inhabited at the time of the Spanish conquest, con-

stituting, with Zuni, Neutrias, and Ojo de Pescado, the *Seven Cities of Cibola*, mentioned frequently by Castañede in the description of his travels in 1540. The opinion of the chief officer of this expedition, Lieutenant Wheeler, is in accordance with the views of General Simpson, Lieutenant Whipple, Mr. Gallatin, and other ethnologists. Moreover, the governor of the Zuni informed us that all the ruins in question were once thriving towns of his people. In connection herewith it may be mentioned, that near Zuni is a rock with an old Spanish inscription, which our party photographed.

FIG. 6



GROUP OF ZUNIS.

The Zuni number about 2,000 souls. In summer, parts of the tribe resort to the smaller settlements—one at Neutrias, the other at Ojo de Pescado (respectively about twenty miles from Zuni town)—to cultivate their farms in those sections. Their fields do not compare unfavorably with those of the Mexicans.

In appearance, the Zuni are a mixture of Mongolian and Caucasian. The complexion is olive, rather than dark-brown; hair straight and jet black; eyes black; cheek-bones very high and prominent; their height and general *physique* correspond to the average among the

whites. Their dress is simple, that of the men being merely cotton drawers and shirt, with blue woolen stockings of their own manufacture; a turban of wool or cotton completes the male attire. The females wear a gown of wool, held at the waist by a sash of the same material; the arms and shoulders are left bare; their stockings same as those worn by the men; for shoes, both males and females wear moccasins of buckskin. When in the street, the women cover the head and shoulders with a white cloth.

Among the Zuni, as well as other Pueblo Indians, are many albinos, and, as interesting to those inclined to the Darwinian theory, it may be stated that the production of this "improved stock" is not due to any mixture of white blood. The skin, and sometimes the hair, of these singular specimens of humanity, is perfectly white, while their eyes are of a reddish hue. The mother of an albino being asked why, she being *brown*, her child was *white*, made no reply; her fierce look, however, expressed more, perhaps, than her language would have revealed.

FIG. 7.

HIEROGLYPHICS AT MESA PINTADA.

Several tribes of Pueblo Indians have been contaminated by contact with the Spaniards, but the Zuni are still pure, and free from taint through Spanish influence. They are simple, though ceremonious in manners—the latter trait undoubtedly acquired from occasional association with their Latin conquerors. They are extremely hospitable, and, after short acquaintance, are apt to prepossess the

stranger and to command his respect. The females are chaste, reserved, extremely modest and rather shy, avoiding, when possible, the gaze of the stranger. Many of them are quite pretty, of fine figure and regular features. Their want of personal cleanliness, however, was apparent, and is certainly singular, in view of the neatness which pervades their dwellings.

One cannot but admire their regard for truth, their industry, unobtrusive disposition, hospitality and respect for strangers. Their hatred of the Mexican is intensely bitter, and is not concealed. On every favorable occasion they give vent to expressions indicative of outraged feelings by reason of the persecutions that have been inflicted upon them by their enemies; and these, together with the feeling manner in which they are made known, warrant the belief that the injuries they have suffered have been numerous and severe. Their love for and kindness toward the people of the States (or "Americans," as they call them) are in striking contrast with the hatred and revenge they bear the Mexican. Yet the benefits they have received from our Government have been neither many nor great.

Although perhaps these Indians, like all Pueblos, do not impress the stranger very favorably on first sight, on closer acquaintance one is forced to yield to the conviction that they are among Nature's noblemen—that they are the descendants of a race long freeholders of the soil of the North American Continent, and are every way worthy of confidence and respect. They are by no means to be compared to the nomadic tribes of red-skins, everywhere infesting the prairie, plain, and mountain of the far West, for murder and plunder. Like other Pueblo tribes, these people show marked and distinctive peculiarities, not that they differ essentially in type from the other branches of the great aboriginal families, but as regards their originality in costume, and their strong conservatism. Industrious and self-sustaining, they are temperate and quiet; though receiving but little aid from the General Government, they are well to do, and particularly in the line of farming.

As evening drew near, we prepared to bid adieu to Zuni town and its inhabitants. On leaving, the governor, with his cacique and the prominent men of his tribe, followed us to the outskirts of the village, when, with uplifted hands, he gave us his benediction, imploring the God of the Zuni to give us safe return to our camp, and, at the close of the field season, to our homes and kindred in the distant East.

A pleasant day with this isolated band of self-supporting, half-civilized people, was profitably spent, many facts being gained regarding themselves, their ancestors, their peculiar manners and customs, as well as respecting their language. These data, when properly discussed and elaborated, will constitute additional information of interest to the general reader, as well as of value to the student of ethnology and philology, and may, moreover, throw new light on the

history of the North American aborigines, of whom but a handful remain to tell the story of their former greatness, or the extent of their ancient civilization.

FOOD, AND THE DEVELOPMENT OF MAN.

By OTTO ULE.

TRANSLATED FROM THE GERMAN, BY J. FITZGERALD, A. M.

THE progress of science does not consist merely in the discovery of new facts and the enlargement of our knowledge, or even in the ingenious conclusions thence drawn, and which, from their universality, acquire the character of laws; its mightiest work is the change it brings about in our fundamental conceptions, and the consequent revolution in science itself. As science advances, it gains new principles, new arguments; its problems and its aims multiply incessantly. There is no branch of knowledge that has not experienced this, and even historical investigation is no exception. Time was when the earth used to be regarded as merely the temporary abode of man, or even as the place where he spent a brief term of banishment. The history of man used to consist of casual events, or of the free and arbitrary doings of individuals. Great men, great heroes, great rulers, great thinkers, determined the history of peoples and of states. Trifling causes—the walling up of a window, or the spilling of a glass of water—might occasion events that would convulse the world. By the aid of natural science we have come to look on the earth as something more than the temporary abode, as the true home and school of mankind. Man has become a child of Nature; in Nature are all the conditions of his life and development. Climate and soil, the conformation of the land, and the distribution of water, determine the physical and the mental development of nations. It has long been seen that peoples differ, that their history and their civilization are different, accordingly as they live in valleys or on mountains, in islands or in the interior of continents, in deserts and steppes or in forests, in an open, hilly country, or in sequestered valleys. Historical research, however, has but recently begun to concern itself with the natural causes of the development of civilization, and many an important aspect of this subject is still entirely overlooked.

Of all the influences which determine the life of the individual, and on which his weal and woe depend, undoubtedly the nature of his food is one of the weightiest. Every one has for himself experienced how not only the strength of his muscles, but also the course of his thought and his whole mental tone, is affected by the nature of his food. And shall not that hold good for nations which holds good for individuals? Shall the sum of mankind be less affected in their physi-

cal and mental development by the food they take, than the individuals of whom that sum is made up? This seems to be the decision of history. Philosophers (even the great thinker of Königsberg himself) have not a word to say about the influence on human races and peoples of different food-supplies. The world heard at first with astonishment the saying of a famous scientific man, that, "could man live on air and water alone, such notions as master and servant, prince and subject, friend and foe, hate and love, virtue and vice, right and wrong, etc., would have no existence, and political communities, social and family life, human intercourse, commerce, trade, and industry, art and science—in a word, whatever makes man what he is—depend entirely on the fact that man possesses a stomach and is subject to a law of Nature which compels him daily to take a certain amount of food."

As we start out with the principle, too late recognized in historical research, that the selection of articles of food is not only important for the personal well-being of the individual, but that it is a weighty, world-stirring question for countries and nations in its bearings on the history of civilization, we will, therefore, endeavor to look closely into it, and study the mode in which this influence is exerted.

If nations are to flourish, they, no less than individuals, need wholesome, strong food. The only question is, How are we to determine what food is strong and wholesome? Foods have been classed in different groups, according to the influence they have on the body, in virtue of their essential constituents; and though this classification, like every artificial classification we make in Nature, is only approximately correct, still it gives us some ground to stand on. Blood-formers, or albuminates, are those albuminous materials which constitute the nutritive elements of the blood, and enter into the composition of the muscles, bones, sinews, and ligaments, on which the exercise of force specially depends. The heat-producers or respiratory foods are those rich in carbon; these specially serve to support, with the aid of inspired oxygen, the process of combustion so necessary for the purposes of the organism. Finally, there is a third group of nutritious substances—the nutritive salts—which are of an inorganic nature, and which, after combustion of the food, remain in the shape of ash.

All these food-materials are essential, since with them the organism is built up. Life is an unceasing process of waste and repair, and the food must make good the loss the organism suffers every instant. Even those substances which are contained in the living body only in small quantities must be supplied, for on this depends the activity of important organs. Such substances are common salt, potash, lime, magnesia, phosphoric acid, and, above all, iron, without which the blood-corpuscles would lose their vitality. But none of these groups is, by itself, sufficient for nutrition; they must all be

combined. Blood-formers, heat-producers, and nutritive salts, are not separately foods, but only factors of food, each as indispensable for the vital processes as air and water, but each incapable by itself of supporting life. One cannot live on albumen alone or on fat alone. Without lime-phosphate no bone would be formed, no matter how much pure albumen and fat we ate; and without albumen no muscular tissue would be formed, though we were to gorge ourselves with sugar and salt; finally, without fat, no brain. But we properly enough give the name of foods to meat, milk, and bread, for in them all the three conditions are present.

Fortunately, these nutritive principles are found by no means sparingly distributed throughout Nature; under the most varied forms they occur in almost every food-stuff used by man. We not only find the blood-formers in the shape of fibrine in the blood and muscles of animals, of albumen in eggs, of casein in milk, of lime and areolar tissue in cartilage, sinew, and skin, but also in the vegetable kingdom; we discover them in the gluten of grains, in the legumine of pulse, in the vegetable albumen of sundry roots, leaves, and fruits. Heat-producers are furnished, not only by the animal kingdom in its fats, but by plants also. Sundry seeds give a small quantity of oil, but the principal supply of heat-producing elements derived from the vegetable world appears in the shape of starch, gum, and sugar—substances which, during the process of digestion, are transformed into fats, and therefore may replace the latter. Finally, we have salts in the water we drink, and more abundantly in nearly every animal and vegetable substance we consume. Hence, it might seem to be an easy thing to find wholesome food, as though one had only to seize blindly the store of food offered by Nature, in order to get all that our organism requires to keep it vigorous. But it is not to be forgotten that, while the nutritive elements make up the losses of the organism, and renew the body, as it were, still they must be taken in certain definite proportions. Now, in Nature they are not distributed in any such proportion. There the greatest diversity is found; one food-stuff consists principally of blood-formers, another of heat-producers; this one contains only one of the nutritive salts, that one, another. If, then, we let chance decide in this matter, it might easily happen that we would take one element in excess, while we took none at all of another. If this were the case again and again, or permanently, the organism must suffer or perish utterly; for, suppose only a single organ to be improperly nourished, i. e., to receive food insufficient to make up its losses, the check given to this one will affect all the rest. Science can now pretty accurately determine the composition of every article of food, and hence its contents of the various nutritive principles. This is done by chemical analysis. Chemical analysis, however, is of little assistance to us in determining accurately the constituents of

our daily food. For, if one, being over-anxious on this point, wished to avoid all danger by having all his food examined by a chemist, so as to apportion by weight the amount of this substance and of that which he should take, there is reason to fear that he would die of hunger long before the chemist had concluded the analysis. Fortunately, there is a better method of avoiding danger, and of this we wisely make use under other circumstances. When we would protect ourselves against the chance which gives up our houses to destruction by fire, or when we would secure our dependents against the accident which deprives us of life and them of a protector, we take out an insurance policy on house or life. But this insurance is not a transaction between two or three, but between hundreds of thousands and millions. A mutual insurance transacted between three persons were a game of chance, between millions it is a sure calculation. We defeat chance, when we share it with others. To apply all this to the matter in hand: we must not restrict ourselves to a few articles of food, but must have a great variety of foods to select from; we must not partake of the same fare day after day, but must vary it as much as possible. Only with a varied and alternating dietary can we be sure that what is lacking in one food-stuff will be supplied in another, and that what we fail to get to-day we shall have to-morrow. What is commonly regarded as simply the result of a spoilt palate, viz., the repugnance excited by the steady recurrence of the same dish, is an uprising of the organism itself against a food which does not meet its requirements; or, rather, the consequence of a deficiency already established.

Here we have an important rule for determining a wholesome diet. The foods we use must contain the indispensable elements of nutrition in due proportion; our food must be mixed, varied, and alternating. And what is here said with regard to individuals, holds good also for nations. The food-stuffs of an energetic population are up to the standard only when they are multifariously blended, and when there is a due proportion of substances belonging to the three groups mentioned above. Now, this relation between the nutrition and the physical and mental development of a people must be apparent in the history of their civilization. Where the food is insufficient, fluctuating between want and excess, uniform and undiversified, the capacity of the people for work must be inferior; their bodily strength and their mental culture must be of a low grade.

But, when we turn our eyes to the pages of history for a confirmation of this, we meet with our first real difficulty. History tells us much about deeds of heroism, bloody wars, conquests, and revolutions; of politics, manners, and customs, and even of the thoughts that have occupied the minds of nations; but of their *cuisine*, their bill-of-fare, history tells us nothing. And yet a history of the foods of nations would be an addition of great value to the history of human civiliza-

tion. From it we should learn by what means and in what way the men of prehistoric times came into possession of their food-stuffs; and this would be a long story full of deeds and full of suffering. Fortunately, we possess other original documents besides the annals of history; documents, too, that antedate all written history, and which are no less trustworthy and unambiguous. The ground under our feet has preserved them in its strata; they rest in barrows and in caves, and in the bottom of lakes and bogs, and these primitive documents are not silent as to the food of extinct nations.

In the present status of research, the earliest authentic traces of man on earth go no further back than the age of ice, so called, and the accompanying or subsequent formation of the diluvium or drift. The relics of man dating from an earlier epoch, the upper Miocene formation, that is, the middle of the Tertiary group, which are said to have been found in France, are at least very questionable. But there have been preserved for us in caverns remains dating from the Ice Age, which tell us of the food used by man in those times. Man then inhabited Central Europe in company with the reindeer, the cave-bear, and the mammoth. He was exclusively a hunter and fisher, as is shown by the bones of animals found in his cave-dwellings. The miocene vegetation, which abounded in arboreal fruits, had disappeared during the long period of the subsequent pliocene formations, the climate of Central Europe, meanwhile, having gradually become colder. Nature supplied no fruits for the food of man. What food he got by hunting and fishing was precarious, and there were intervals of famine; for fortune does not always smile on the hunter, and the beasts of the forest are not always equally numerous. The food, too, was uniform, and not altogether adapted for man, for the flesh of wild animals lacks fat. The man of those times had not enough of the heat-producers in his food; and that he felt this want, we learn from his taste for the marrow of bones. All the long bones of animals that are found in cave-dwellings are cracked open lengthwise, in order to get out the marrow. Now, this insufficient, uniform food has its counterpart, in the low grade of culture which then prevailed, as evidenced by the mode of life, the weapons, and the tools. Man then lived isolated, without social organization; he dwelt in caverns, and his only protection against the cold was the skins of animals and the fire on the hearth. His tools were of stone, unpolished, unadorned; so rudely fashioned, that only the eye of the connoisseur can recognize in them man's handiwork.

Let us now advance a step further, and glance at a time a few thousand years nearer to our own, the period of the ancient pile-dwellings. Man then built up huts, and even villages, on piles, in the midst of lakes. These piles have been discovered, and between them, on the bed of the lake, oftentimes overlaid with peat several feet in depth, lie the monuments of those times—the waste of the house and

of the kitchen. Some of these lake settlements, that near Robenhausen, in the Pfäffikonsee, for instance, were clearly destroyed by fire, and under their charred remains is buried every thing that had been contained in the eating-rooms. The lake-men, too, were hunters and fishers, and they still hunted some of the same animals as the cave-men—only the cave-bear, reindeer, and musk-ox had disappeared. They pursued fishing probably with greater success than their predecessors, for they not only employed harpoons made of bone and reindeer horn, but had learned to make nets of flax-fibre. But they, furthermore, had begun to raise cattle; they had domesticated animals—goats, sheep, two species of swine, and two of oxen. Probably, too, they used the milk of cows, and even seem to have understood cheese-making, for twirling-sticks and perforated vessels have been found which can hardly have been used for any other process. The food-supply of the lake-men, therefore, was more assured than in the Ice Age, and also more varied; for they were, furthermore, agriculturists. They grew wheat and barley, ground the grain with querns, made porridge and bread. Remains of this porridge, as it is supposed, have been met with in pots; and flat cakes, in a charred condition, are found abundantly in the pile-dwellings of Wangen and Robenhausen. Sundry kinds of fruit, also, served for food. Dried apples and pears—wild-apples and wild-pears, it is true—blackberries, and hazel-nuts, have been taken in great numbers out of the bogs. The food of the pile-villagers was thus very abundant and diversified, and to this better nutrition answers a considerable advance in culture. The lake-man did not inhabit caverns, nor did he clothe himself in skins, as did the man of the Ice Age, but built himself wooden cabins, and wore clothes of flax. Considerable stores of flax have been found, and it is even supposed that pieces of the simple fabric have been discovered. These people lived in populous villages, and hence undoubtedly had a social organization. Their tools and weapons are of stone, it is true, but nicely polished and ornamented. Their unmistakable love of the beautiful testifies to their progress in culture.—*Die Natur.*

MATERIALS OF THE SCIENCE OF LAW.[1]

By SHELDON AMOS, A. M.

IN order to ascertain what are the materials of the Science of Law, it will be well to cast a glance at the subject-matter, in its rudest and most inartificial shape, to which the science relates. For this purpose the case may be taken of a nation in what may be called the

[1] From advance sheets of "The Science of Law," forming Vol. X. of the "International Scientific Series."

early manhood of its life, after all the early struggles for its self-conscious existence, or for its independence, are over; and yet, before it has developed within itself all the complicated machinery of a highly-organized commercial and social life. In such a state there must, by the very hypothesis, be a more or less steadily fixed government, whether that government approach more to a monarchical, or an aristocratical, or a democratical type. The stability of the state, and its self-dependence, imply agriculture, and agriculture implies property or ownership. The division of labor, again, which this economical condition presupposes, involves the habit of making contracts, even though they be of the most elementary form. The social condition cannot but rest upon a previously-developed, though now strongly-fortified, domestic condition, and this implies the fact of marriage, and the relations of husband and wife, parent and child, brother, sister, uncle, aunt, nephew, niece, and the like. The still remaining anarchical tendencies of certain individual members of the state, lagging behind the rest, will generate occasional acts of violence, threatening, directly or indirectly, the very life and existence of the state. These acts will excite the horror of all the more orderly members of the community, and will be denominated by some such term as *crimes*.

It is obvious that the characteristic classes of facts, which have just been alluded to, are so general and simple, that their necessary occurrence at a certain epoch, in the progress of every state, may be predicted as a certainty. These facts, however, in themselves, are of the utmost possible moment, and involve, by their permanence and universality, the elementary ingredients of a science of law.

It will be seen that these facts, looked upon as a whole, imply, first, a certain number of definite relations of persons to one another, whether as governors or governed, husbands or wives, parents or children, or as otherwise allied by blood or marriage. Secondly, these facts involve certain determinate relations between the persons in the community, in respect of the things (or physical substances) appertaining to the community as a whole. These things, severally, are owned by one or another, and not by the rest. The ownership of these things is the subject-matter of private arrangements and contracts between different members of the community. The violent or fraudulent abstraction of a thing owned from the owner may be one of the acts on the general prevention of which the very life of the community is held to depend, and as such is denominated a *crime*.

Again, the classes of facts already enumerated have two distinct sides to them, one touching the outward lives of members of the community, that is, their *acts;* the other touching their inward lives, that is, their thoughts and feelings. Over the former of these sides the whole of the community can, by its aggregate pressure, exert a considerable amount of force, of a specifically ascertained quantity and quality. Over the latter side, that touching the thoughts and feelings

of individual members, the utmost direct pressure, consciously exerted by the community, is of the feeblest efficacy, and, at the best, indefinite and precarious in the highest degree. The sphere of action of the community, with respect to the former, or the acts of men, is that of law. The sphere of action with respect to the latter, that is, the thoughts and feelings, though not exclusive of acts, is morality. The relations of these two spheres to each other will be investigated in the next chapter.

In the mean time, the following conclusions have been reached: It appears that the characteristic energy of every state consists in the reciprocal influence upon each other of the corporate whole, and the constituent elements, in respect of certain definitely assignable classes of human action. These classes of action will either have reference to things or physical substances, as objects of ownership or use, or have no such reference. The actually subsisting relationship to each other of the corporate whole, and the constituent personal elements, depends upon the form of government which casually happens to prevail.

The influence of the constituent personal elements of the state upon its governing authority, as representing, at any epoch, the corporate whole, is exhibited, first, in the selection (whether conscious or unconscious) of that governing authority according to its specific modifications; and, secondly, in the incessant control (conscious or unconscious) of that authority, by which the limits of its free action are, at every moment, defined. The influence of the governing authority, on the other hand, on the constituent personal elements of the state—that is, upon its so-called "subjects"—is exerted through two separate channels: one that of administration; the other that of law. In other words, the purposes of government are effected either through the medium of occasional and, as it were, spasmodic injunctions, or through general rules.

The limits, within which any given governing authority can venture to issue occasional injunctions, must be determined, as has already been seen, by its actual relations to all the constituent personal elements of the state. These limits will never be precisely determined in language, though they will be marked with tolerable exactness in fact, and instinctively appreciated by all persons concerned in either enlarging or protecting them.

The determination of these limits of administrative authority might be looked upon as forming one great branch of the general rules which constitute the other field of the appropriate activity of the government. It composes a large portion of what is called "constitutional law." The anomaly, however, attaching to this extension of the term "law" is obvious, inasmuch as, if the name "law" be given to the body of general rules through which a government exerts its appropriate activity, the same term "law" cannot be simultaneously ap-

plied to the limits affixed to its freedom of action. But this objection, when once understood, is of little practical importance. It is sufficient to establish that there are certain definite limits which circumscribe the free action of every governing authority, and that these limitations admit of being formulated into more or less precisely articulated propositions. Such propositions, capable as they are of being handled, interpreted, and enforced, in courts of justice, have all the essential qualities that belong to the general rules framed by the governing authority itself, for the guidance of the conduct of all persons submitted to its dominion.

The topics of these general rules or laws will be those matters which have already been described as essentially inviting the direction of the corporate strength of the community. Such matters are the relations of family life, so far as outward actions and public decorum are involved, the security of property, the protection of individual liberty, the enforcement of contracts, and the prevention of those violent and exceptional excesses denominated crimes.

At a very early period in the history of the community, the interest that each citizen has in the wise and effectual regulation of such matters as these becomes conspicuous to all, and more especially to those usually, or, on the average, more advanced and intelligent members of the community who find themselves charged, through, it may be, a series of political vicissitudes, with the duties of government. It is probable that these several and various objects will attach to themselves, at different epochs, a very unequal and disproportionate share of attention.

The security of property may alternate with security of the person as an object of governmental care; and the classification of crimes and civil injuries, or even of crimes and religious offenses or sins, may be, in the highest degree, irregular and unsystematic. The vices, the selfishness, the ignorance of individual rulers, will, from time to time, bring into relief some classes of laws to the disparagement or neglect of others. At one epoch a state will suffer from having too few laws, at another from having too many. Particular classes of persons may lose or gain at one period of legislation, and other classes may lose or gain at another. These eras and disasters are of none the lighter consequence that they have been universal. It is in spite of them, and not by means of them, that states have finally endured and fought their way to a climax of intelligent legislation and conscious political life. In the case of such states, the heart of the people, as estimated from generation to generation, has been sound, and the heads of their rulers wise. The laws have gradually been adapted to promote individual liberty, and not to impair it; and the province of government has been so mapped out as to make the government an institution conducive to the good of the people, and not a mere organ for the sacrifice of a nation to a class.

It will have been seen, in the above description of universal phenomena, that a purely abstract mode of treatment has been adopted. So far as universally confessed historical facts are presupposed, the truth of such facts is boldly assumed. But the main basis of the arguments are the elements of human nature itself, as they are written, not only in the venerable documents of ancient history, but on the face of every traveler's narrative, of every ancient body of laws, of every honored institution subsisting in the midst of the national life of the most advanced countries of Europe. It is obvious, then, that the generality and permanence of the momentous facts above described afford the groundwork of a great science, the Science of Law.

This science is distinguishable from the Science of Ethics, to which it may be coördinated, as well as from the Science of Politics, to which it is subordinated. The materials of the science are: a description of—1. The essential institutions of human society, by the use of which the objects of that society are carried out through the medium of government; 2. The nature, conditions, and limits of *law* as an expression of that side of governmental action which consists in the enumeration of general rules of action; 3. The accidents of law, such as language and interpretation, terminology, and devices for legislation.

When these materials are carefully scrutinized, it will be found that they are composed of elements as permanent and universal as the elements of human nature itself. All that is arbitrary and idiosyncratic for any particular state is banished from the inquiry. The surplus is as applicable to one state as to another; to the most immature system of law as to the most advanced; to an Eastern as to a Western community; to the modern as to the ancient world.

It is curious that this universality and permanence have been generally conceded to ethical truths, and have latterly been more and more freely conceded even to political phenomena, modified indefinitely, as these must needs be, by the excessive complexity of the conditions which constitute them. But the region of law has, up to a recent time, been held to be the natural home of caprice and irregularity. Some writers, indeed, such as Montesquieu and M. Charles Comte, have quoted the varying laws in the different countries of the world with almost an ironical gladness at their *bizarre* and party-colored appearance. It has been very generally held that governments have been created by violence or accident, and have reflected the vices of their origin in the reckless selfishness of their legislation. It has been said again and again that force is the origin of all social institutions, and that the modes of directing that force have been determined in every state by the chance breath of political caprice or passion. It has been forgotten, or has escaped notice, that the caprice has been accidental and the order is essential.

It will be noticed that there are two distinct conceptions of human

society which are both possible, if not both true, and that the existence of a Science of Law follows as a necessary consequence of the adoption of one conception, but does not follow from the adoption of the other. It may be said, on one theory, that the composition and action of human society, as exhibited in the state, are due to nothing else than the aggregation and mutual repulsion of a number of independent and self-conscious atoms which, by a gradual process of experience, have discovered that the largest measure of individual well-being is solely attainable through certain special modes of coöperation. These modes of coöperation take a variety of forms, but the most signal and important are those implied in the facts of government, ownership, the composition of the family, and contract.

According to the theory now under review, every one of these facts is merely a device for carrying out ends believed to be beneficial. The facts might be made to vary indefinitely, and it is alleged to be conceivable that any one of them, and perhaps every one, might be absent altogether and a new set of devices take their place. It is held to be possible that the devices themselves will, at no remote period, be discovered to be rude and insufficient, and that many superior substitutes could be found for them, even if they do not already exist in certain societies, the constitution of which is as yet unexplored. The machinery by which each one of these classes of facts is called into being, and made to subserve its end, is physical force, taking the form of what is called law. The physically stronger part of the community compels the weaker to obey a certain form of governing authority, to recognize certain descriptions of ownership, to conform their lives to certain canons of domestic life, and to observe certain regulations of the market and the exchange. The rules, indeed, enforced by law are, for the most part, so transparently beneficial to all concerned that the pressure of law becomes very slightly felt, and the physical force which supports it is comparatively seldom called into play. Nevertheless, in the theory now being enunciated, force is not only present, but the main originator and upholder of every portion of the fabric of social order. It is obvious that, according to this view, there can only be a Science of Law in a very restricted sense. In the largest sense of the expression there can be none. Instead of law having any precise and determined character impressed upon it and upon its operation, through the existence of a certain number of immovable social institutions, which react back as effectually upon law as law acts upon them, these institutions are nothing more than the creations of law itself, or rather the accidental shadows which law happens to cast.

The opposite theory of society starts with the conception that society is not developed through the conflicting passions of individual atoms striving to organize themselves after a fashion which shall best promote their own well-being, but is from first to last a subsisting organization made up of constituent groups reciprocally acting and

reacting upon one another. The elemental forms and tokens of this organism are family life, ownership, and government. Each of these presupposes coöperation and contribution at all stages in the history of society, though under different forms; each of them implies the distribution of mankind into small groups rather than into large masses of individual atoms. It is difficult to say that any one of these original elements has precedence in point of time over any one of the others. It is more true to say that, when once they are all found to be in existence, the state has then and there come into being. A very short time passes before another element—that of contract—implied in all progressive industrial coöperation, also comes to the surface.

There are thus formed in the primitive state a certain number of elemental institutions which may be looked upon, not in any sense as the creation of law, but as existing independently of law; for the spontaneous arbitrary action of a primitive government resembles what is now called "administration" rather than law. It is true, however, that law, in the immature form of regulated usage, will be found to be one of the earliest of all the ingredients of the state. It will be, indeed, even from the first, the regulator and the guide of the other institutions with which it is contemporary, but is in no sense their parent or solitary guardian. Nevertheless, as time goes on, the support that law gives to the integrity of family life, to property, to industrial and commercial relations, and to government, becomes important in the highest degree. Indeed, the prominence of the legal supervision exercised in a highly-developed state over all these departments, affords an apology for the familiar notion that they are all the arbitrary creation of law and depend for their continued subsistence upon no greater or deeper sanction than that of physical force.

If it be true, then, as this last theory asserts, that in every state there are a limited number of great pivots, or turning-points, round which human society revolves, and the law only plays a subordinate part in regulating and protecting the grand mechanism, it is obvious that a permanent and universal body of facts relative to law may be at once anticipated to result from the permanence and universality of the great groups of facts with which it happens to be mainly conversant. Experience and observation confirm this anticipation. Every known system of law, both of ancient and modern times, in all parts of the world, and in all stages of national development, distributes itself into the main divisions of laws determining—1. The nature, functions, and limitations of the governing authority; 2. The forms and conditions of ownership, whether of land or other things; 3. The relations of family life; and 4. The binding force of voluntary promises or contracts. These several topics afford a natural method of distribution applicable to every legal system whatever; and each several topic, according to its peculiar nature and to the incidents by which it is inter-

nally characterized, affords a distinct congeries of logical subdivisions which is invariably reproduced over and over again.

It is, then, in this identity of structure of human society in every state, that law discovers for itself the basis of its constantly-recurrent methods of classification and its unchangeable conceptions. There are, however, certain other more obvious grounds for the permanence and invariability of legal ideas and methods which follow from the identity of man's physical, logical, and ethical structure in all times and in all parts of the world, within the limits to which observation has hitherto extended.

Law in its outward character consists of a body of commands addressed to individual members of the human race forming the component elements of a state. The issuing of commands involves the possibility of obedience or of disobedience, and therein supposes the presence of will, of liberty of action, and of the amount of intelligence needed to understand the purport of the commands. Attention is thereby compelled to the exceptional cases in which the terms of the command cannot be understood, whether through temporary incapacity, as infancy, error, or passing disease; or through permanent incapacity, as life-long insanity; or in which the terms cannot be complied with, through the pressure of external force, the interference of persons actuated by fraudulent motives, or the obstruction of physical facts creating the condition of impossibility.

Supposing, however, that the command can be understood and can be obeyed, there will be nevertheless cases presented in which the question has to be decided whether, as a matter of fact, the command, in a given case, was obeyed or not. Here are let in all the obstacles inherent in human nature itself to acquiring a correct knowledge of facts. All the current imperfections of human observation, all the insufficiency of language and expression, all the chicanery and double-mindedness, all the dullness of intellect, by which it becomes so hard to pass truth on unimpaired from hand to hand, are present to hamper the effort to apply and execute a single law. The several forms of these obstacles, however, are not peculiar to any one state nor to any one period, however their magnitude may vary. They are universally present, and can be classified under a comprehensive scheme.

But another and universal class of difficulties in executing a law has yet to be mentioned. It may be uncertain what are the form and intent of the law itself. If the law is written, the terms of the language in which it is written may admit of all sorts of ambiguity or vacillation in meaning, or, however certain the terms themselves, the opposed disputants may insist on different senses being put upon the whole text of the command.

If the law is unwritten, and has to be gathered either from traditional report or by reference to the rules which have been laid down on previous occasions in cases resembling the one now calling for de-

cision, opportunity is presented for all sorts of logical conflict as to the import of the previous cases cited in illustration, or as to the value of the analogies insisted upon.

In other words, a series of logical processes is involved in the *interpretation* of every law, whether written or unwritten, and the correctness of these processes may furnish ground for indefinite doubt and argument. But these logical processes are permanent and universal, and the application of them to the interpretation of law imparts their own permanence and universality to the Science of Law.

It has thus been seen that the intellectual and the ethical nature of man in all nations tends to impart a scientific character to the study of the laws by which his social actions are regulated. The physical facts of his life and bodily constitution tend to the same end. His birth, his death, his age, his liability to diseases and accidents of all sorts, his capacity of locomotion, and his several relations to time, space, quantity, measurement, and the like, further discover fresh categories into which portions of the laws which regulate his conduct, and describe his situation, under varying circumstances, in relation to his fellows, necessarily fall.

Besides the elements of the Science of Law which are discoverable within the limits of a single state, and even of the most miniature one, there are others which are developed only in the course of time, as states multiply in number, and as their relations to one another become strictly defined.

The relations of states to one another are twofold in character. Either the governments of the different states have relations to each other, or the individual citizens of the different states have relations to each other.

The first class of relations gives occasion to what is called Public International Law, and the latter to what is sometimes called, with less precision, Private International Law.

It is plain that, if the rules regulating the relations of states are true law in any sense, they are identical for all the states subject to them. The same ought to be the case with respect to the rules regulating the recognition of the laws of foreign states. But there are certain obstacles which have, in fact, prevented the uniformity of substance which might have been anticipated in this region of law.

The rules of the species of law last indicated come into being through the moral claim that is presented either by persons who, not being citizens of a given country, come to the courts of justice of that country, while sojourning there, to have rights recognized and protected which they have acquired in their own country; or by those who, being citizens of one country, but having acquired rights while sojourning in other countries, come to the courts of their own country to have those rights recognized and protected.

On every occasion for inventing rules applicable to these cases, the

question is presented whether the courts of justice of a country shall recognize rights acquired either by their own citizens or by foreigners in other countries; or, in other words, whether the laws of other countries giving validity to those rights shall or shall not be held to be effectual in the courts of justice which are invited to interfere. The cases are generally further complicated by the nature of the processes and transactions out of which the asserted rights spring. Part of the transactions may have taken place in one country, and part in another, and the remedy may be sought for in a third. Or the person seeking the remedy, or against whom the remedy is sought, may be the citizen of one country, have his permanent residence or domicile in another country, and be temporarily sojourning in the country in which the remedy is sought.

It is obvious, from a mere enumeration and description of the cases which give rise to rules, that the purpose of the existence of these rules is always the facilitation of intercourse between the citizens of different states, and the prevention of practical injustice. These objects must be served in the highest degree, if the greatest possible uniformity of principle obtain in the courts of all nations in creating and applying the rules. In this way reasonable expectations are likely to be best satisfied, and fraudulent evasions of the law of any particular country are likely most effectually to be prevented. It happens, however, that, owing to the political jealousies that have have hitherto kept apart the most considerable nations of Europe, and to the foolish prejudice with which individual nations have fostered principles of law familiar in their own courts, however alien to the practice of all other countries, there have hitherto been made only very imperfect attempts at uniformity either of principle or practice in this respect.

It is probable that an increasingly clear apprehension of the logical relations of the different branches of law, whether as touching upon ownership, contract, family life, or crime, will produce the effect of assimilating the substance as well as the form of the rules of law forming the so-called Private International Law of different countries. This end is perhaps one of the most practical and desirable that the Science of Law could set before itself, though it will need at every point the aid of the Science of Legislation. This subject will be recurred to again in the chapter on Laws of Procedure.

It appears, then, from the above investigation, that there is a true Science of Law based upon the irrefragable, permanent, and invariable facts of the constitution of human society, as exhibited in the state of the physical, logical, and ethical constitution of man. The objects of the cultivation of this science are, first, the ready understanding of every system of national law, through a firm hold being obtained upon its technical structure, its topics, its logical subdivisions, and the methods of its application; secondly, an orderly view of the whole system of law of any one country in order to its comprehensive amend-

ment, reform, and intelligent reconstruction in obedience to the needs of a new political and social era; thirdly, the attainment of a clearly expressed, rational, and well-developed system of Public International Law; and, fourthly, the reduction of the irregular, and sometimes chaotic, or arbitrary, rules of so-called Private International Law, as adopted in different states, to a uniform system, the same for all states.

THE ALLEGED ANTAGONISM BETWEEN GROWTH AND REPRODUCTION.

By Rev. ANTOINETTE BROWN BLACKWELL.

THE supposed law of inverse relations between growth and reproduction was first announced, I think, by Dr. Carpenter; but adopted independently by Mr. Spencer, whose elaborate, forcible arguments have done much to convince many physiologists that a principle so well established may be accepted without further question. But the underlying facts are so various, complex, and unsolved, it is by no means impossible, or even improbable, that some new element yet to be introduced into the premises may partially modify or even reverse the necessary logical conclusion.

The following are Mr. Spencer's main points, gathered from his "Principles of Biology," and stated in his own condensed language: "Genesis, under every form, is a process of negative or positive disintegration, and is thus essentially opposed to that process of integration which is one element of individual evolution."[1]

"When the excess of assimilative power is diminishing in such a way as to indicate its approaching disappearance, it becomes needful, for the maintenance of the species, that this excess shall be turned to the production of new individuals; since, did growth continue until this excess disappeared through the complete balancing of assimilation and expenditure, the production of new individuals would be either impossible or fatal to the parent."[2]

"We cannot help admitting that the proportion between the aggregative and separative tendencies must in each case determine the relation between the increase in bulk of the individual and the increase of the race in numbers."[3]

Up to this point one may freely admit the antagonistic relations alleged; but, when, in his article on "The Psychology of the Sexes," Mr. Spencer asserts that "a somewhat earlier arrest of individual development in women than in men is necessitated by the reservation of vital force to meet the cost of reproduction," there are so many not yet discounted conditions to be considered that the position cannot

[1] Vol. i., p. 216. [2] P. 237. [3] Vol. ii., p. 426.

be regarded as satisfactorily sustained. *There is* the "earlier arrest" of physical growth; the "rather smaller growth of the nervo-muscular system;" the much longer nutritive tax demanded for the nourishment of fœtal and infant life; the "somewhat less of general power or massiveness" in feminine mental manifestations; *there may be*, "beyond this, a perceptible falling short in those two faculties, intellectual and emotional, which are the latest products of human evolution—the power of abstract reasoning, and that most abstract of the emotions, the sentiment of justice." It does not therefore follow that these results, any or all of them, are deductions made from the "cost of reproduction." Force modified and readjusted is not force subtracted or destroyed.

The smaller nervo-muscular system, and the diminished power or massiveness of mental action, may be supposed to arise as direct results of the larger nutritive cost of maternity. But the earlier arrest of physical growth may or may not be coupled with an earlier arrest of mental development; and one or both of these may offer to us very marked illustrations—not of process prematurely cut short to be handed over to offspring—but of process quickened by other related antecedents, and therefore more rapidly completed. This need not involve loss or transfer of individual force to offspring; but, rather, a modified system of the transfer of substance and force from the environment to the reproductive functions and their products.

If it could be shown that men or women who are the parents of many children have thereby lost something of individual power, we might then be forced to admit that the greater cost related to the reproductive system in women must be at their personal expense, not at the expense of the nutriment which they assimilate and eliminate.

The weaknesses resulting from a too early or an excessive tax of functions belong to a distinct class of considerations. I assume that every balanced constitutional activity, though including loss of nutritive elements, is yet a normal aid to constitutional strength. Every action, physical or psychical, involves either integration or disintegration; every use of faculty belongs to the latter class. There is no more antagonism between growth and reproduction than between growth and thought, growth and muscular activity, growth and breathing. The antagonism is only that of action and reaction, which are but two phases of the same process—opposing phases which exist everywhere, and which must exist, or action itself cease, and death reign universally.

Growth and eating are antagonistic; yet, one must eat to live as assuredly as children must be reared at the expense of nutrition, and of still more elaborated parental force. Nor is it true that one who expends least has the most remaining. Other things being equal, the law seems to be directly reversed. One activity initiates another;

the largest individual force maintains those more active adjustments, "simultaneous and successive," between the internal and external, which indicate the most vigorous life. We must look, then, to something more than a direct antagonism, between growth and reproduction, to account for unlikenesses of the sexes in plant or animal. "The minutest organisms multiply asexually in their millions;" but "those which do not multiply asexually at all are a billion or a million times the size of those which thus multiply with the greatest rapidity;" yet these comparative rates of growth and multiplication can offer no key to any of the problems of evolution.

Mr. Spencer reasons that birds, as a class, are less in size than mammals, because they habitually expend more muscular energy in flight; and that lions, having a digestive system not superior to men, yet attain to a larger size and are more prolific, because they have a less active nervous system to sustain. Then, if women normally have equal appropriative powers with men, the surplus nutriment not needed for their smaller *physiques* may be constitutionally handed over to reproduction. Natural selection has originated an admirably complete system of related provisions to this distinct end. This fact must lead us to the conclusion that the aggregate of feminine force is the full and fair equivalent of all masculine force, physical or psychical.

The maternal constitution elaborates nutriment, from which it is itself to receive no direct benefit. But, do we forget the inexorable conditions which compel the human father to expend equivalent muscular or mental force to feed, not himself, but his dependents? Whenever man does not interfere, monogamy seems to be the general order of Nature with all higher organisms. Where the cost of obtaining food is great, the parents sustain commensurate burdens in rearing their young; and, with these claims, I think it will be found that monogamy is the primal condition of reproduction. The warlike duty of defense is also borne chiefly by males, and must often be an immense tax on the energies.

Among the beings of a lower type, plant and animal, all the more recent observations indicate that Nature herself systematically favors the females—the mothers of the destined races. Nature's sturdiest buds and her best-fed butterflies belong to this sex; her female spiders are large enough to eat up a score of her little males; some of her mother-fishes might parody the nursery-song, "I have a little husband no bigger than my thumb." Natural selection, whether the working out of intelligent design or otherwise, would make this result inevitable. We might expect that the neuter bee could be nourished into the queen-mother. If required to judge *a priori*, we should decide, if there is no predetermination of sex, that the best-fed embryos would most readily become female; since the one special fact in the feminine organism is the innate tendency to manufacture, and, within certain limits, to store up reserved force for the future needs of offspring.

In women, if there is a greater arrest of individual growth than in men, the difference begins in the fœtal life; their comparative weight and size at birth are the same as at maturity; and, if the former finish their growth earlier, it must be because relatively they grow more rapidly. The feminine circulation and respiration are both quicker; and so are the female mental processes. When the whole subject has been quantitatively investigated with sufficient exactness, I believe it will be found that, what man has gained in "massiveness," woman has gained in rapidity of action; and that all their powers of body and mind, *mathematically computed*, are, and will continue to be, real and true equivalents. The premises are already sufficiently known to compel me to this conclusion.

One point more. Physical and psychical growth in man are not arrested simultaneously. After the body has ceased to grow, the brain-system still enlarging and compacting its highly-mobile structure, mental power increases long after the more rigid, merely mechanical forces have reached their maximum. The same law applies, at least, in equal degrees to woman. If there is any proof that feminine psychical powers normally reach an earlier cessation of growth than the masculine, then, so far as I can learn, no scientist has yet collated the facts and put them before the world in evidence. On the contrary, so far is the earlier physical maturity of woman from necessitating a corresponding earlier psychical maturity, that, in the light of physiological relations, we may deduce the exactly opposite hypothesis.

In woman, maximum mental power should be reached at a considerably later period than in man, because the greater cost of reproduction, though related chiefly to the physical economy, is indirectly psychical; tending to diminish intellectual action also, and to retard its evolution. The cost of all reproductive provisions fully met, and the child-bearing age at an end, the special constitutional tendency to accumulate reserve force will not be immediately destroyed. Functions, active hitherto in the interest of posterity, go on now to accumulate in the interest of the individual. Still further, the naturally less overtaxed intellectual faculties of woman now have *this* advantage also over those of man—an advantage at least as great as the previous disadvantage.

When the vast weight of past social conditions is considered, that women thus far have failed to acquire large powers of abstract thinking and feeling, affords no reason for supposing that there is a corresponding constitutional lack of ability in this direction. They attain an earlier growth, but, that they reach the highest point even of physical vigor earlier than men, we have no evidence. Many facts indicate otherwise. Men and women live to equal ages, retain their vigor to equal ages—those using the greater force more slowly, those the lesser force more rapidly—thus with uneven steps keeping even pace in physi-

cal progress; the greater mobility of all womanly functions being less readily stiffened into inactivity. This principle, applied to the nervous system, should prolong the period of greatest mental activity, and hold the balance which measures the working value of the sexes with even justice.

Is it true that average women to-day are less versed than average men in abstract thinking, feeling, or acting? Not in New England! Not in any locality where they have equal education. They have not become *savants!* But circumstances have not yet impelled them to become such. In these days, philosophers grow by steady accretions, like every thing else. No full-armed Minerva can be expected to spring by simple heredity from a paternal Jupiter; but the laws of mental inheritance are too little known to enable us to decide that the daughters of the nineteenth century are less gifted than the sons. When women are convinced that the antagonisms between growth and reproduction, though embracing all personalities, must yet leave them all intact, every thing else may be left to adjust itself, with no solicitude for the ultimate results.

THE NOBILITY OF KNOWLEDGE.[1]

By JOSIAH P. COOKE, Jr.,
ERVING PROFESSOR OF CHEMISTRY AND MINERALOGY IN HARVARD COLLEGE.

WITHIN a comparatively few years schools for the instruction of artisans have become a prominent feature in the educational systems both of this country and of Europe, and seem destined to supersede the old system of apprenticeships. The establishment of these schools has been an important step in human progress, not because any great advantage has been gained in the cultivation of mechanical skill, but because here the future mechanic acquires culture of the mind as well as skill of the hand. Indeed, it may be doubted whether our utilitarian age can ever successfully compete with those "elder days of art" when

> "Builders wrought with greatest care
> Each minute and unseen part."

But, if our industrial schools do not make better mechanics than the workshops of the olden time, they certainly educate better men, and, by adding to skill, knowledge, they are elevating the mechanic and ennobling his calling.

If, therefore, these schools are the representatives in our age of the workshops with their bands of apprentices in the days of yore, then

[1] An address delivered before the Free Institute at Worcester, Mass., July 28, 1874.

that by which the schools are distinguished, that which they have added to the old system, is not art but mental culture; and therefore, when asked to address you on this occasion, I could think of no more appropriate subject than the Nobility of Knowledge. Identified with an institution in which mental culture is the chief aim, I felt that I was asked to address a body of cultivated working-men with whom, though employed in the mechanic arts, the acquisition of knowledge was also a privilege and a pride. I felt, moreover, that a proper appreciation of the true dignity of knowledge, in itself considered, and apart from all economical considerations, is one of the great wants of our age and of our country.

Knowledge is power. Knowledge is wealth. These trite maxims are sufficiently esteemed in our community, and need not that they be enforced by any one. So far as knowledge will yield immediate distinction or gain, it is sought and fostered by multitudes. But when the aim is low the attainment is low, and too many of our students are satisfied with superficiality, if it only glitters, and with charlatanry, if it only brings gold.

Let me not be understood to depreciate the material advantages of learning. I rejoice that in this world knowledge frequently yields wealth and fame, and I should have little hope for human progress were the prizes of scholarship less than they are. Power and wealth are noble aims, and when rightly used may be the means of conferring unmeasured blessings on mankind; but I desire at this time to impress upon you, my friends, the fact that knowledge has nobler fruits than these, and that the worth of your knowledge is to be measured not by the credits it will add to your account in the ledger or the position it may give you among men, but by the extent to which it educates your higher nature, and elevates you in the scale of manhood.

I address young men who are just entering on life, who are at an age when the mystery of our being usually presses most closely upon the soul, and whose aspirations for higher culture and clearer vision have not been deadened by the sordid damps of the world. Trust no croakers who tell you that your youthful visions are illusions, which a little contact with the real business of the world will dispel. It is only too true that these visions will become fainter and fainter, if you allow the cares of the world to engross your thoughts; but, unless your higher nature becomes wholly deadened, you will look back to the time when the visions were brightest, as the golden period of your life, and let me assure you that, if you only are true to the aspirations of your youth, they will become clearer and clearer to the last, and, as we firmly believe, will prove to be the dawn of the perfect day.

My friends, if you have seen these visions, "the nobility of knowledge" has been a reality of your experience. You know that there is a life lived in communion with the thoughts of great men or with the thoughts of God as we can read them in Nature and Revelation, which

is purer and nobler than a life of money-making or political intrigue, and I would that I could so bring you to appreciate not only the nobility, but also the happiness, of such a life as to induce you to try to live it. Do you tell me that it is only granted to a few men to become scholars, and that you have been educated for some industrial pursuit? But remember, as I said before, that it is your special privilege to have been educated, to have added knowledge to your handicraft, and that this very knowledge, if kept alive so far as you are able, will ennoble your life. Knowledge, like the fairy's wand, ennobles whatever it touches. The humblest occupations are adorned by it, and without it the most exalted positions appear to true men mean and low.

Nor is it the extent of the knowledge, alone, which ennobles, but much more the spirit and aim with which it is cultivated, and that spirit and aim you may carry into any occupation however engrossing, and into any condition of life however obscure.

And let me add that what I have said is true not only of the individual, but also, and to an even greater degree, of the nation. Our people, for the most part, look upon universities and other higher institutions of learning as merely schools for recruiting the learned professions, and estimate their efficiency solely by the amount of teaching-work which they perform. But, however important the teaching function of the university may be, I need not tell you that this is not its only or chief value to a community. The university should be the centre of scientific investigation and literary culture, the nursery of lofty aspirations and noble thoughts, and thus should become the soul of the higher life of the nation. For this and this chiefly it should be sustained and honored, and no cost and no sacrifice can be too great, which is required to maintain its efficiency. And its success should be measured by the amount of knowledge it produces rather than by the amount of instruction it imparts.

Harvard College, by cherishing and honoring the great naturalist she has recently lost, has done more for Massachusetts than by educating hosts of commonplace professional men. The simple title of teacher, which in his last will Louis Agassiz wrote after his name, was a nobler distinction than any earthly authority could confer; but remember he was a teacher not of boys, but of men, and his influence depended not on the instruction in natural history which he gave in his lecture-room, but on his great discoveries, his far-reaching generalization, and his noble thoughts. Although that man died poor, as the world counts poverty, yet the bequest which he left to this people cannot be estimated in coin.

It is a sorry confession to make, but it is nevertheless the truth, that, if we compare our American universities, in point of literary or scientific productiveness, with those of the Old World, they will appear lamentably deficient. Let me add, however, that this deficiency arises

not from any want of proper aims in our scholars, but simply from the circumstance that our people do not sufficiently appreciate the value of the higher forms of literary and scientific work to bear the burden which the production necessarily entails. Scholars must live, as well as other men, and in a style which is in harmony with their surroundings and cultivated tastes, and their best efforts cannot be devoted to the extension of knowledge unless they are relieved from anxiety in regard to their daily bread.

In our colleges the professors are paid for teaching and for teaching only, while in a foreign university the teaching is wholly secondary, and the professor is expected to announce in his lectures the results of his own study, and not the thoughts of other men. Until the whole status of the professors in our chief universities can be changed, very little original thought or investigation can be expected, and these institutions cannot become what they should be, the soul of the higher life of the nation. It is in your power, however, to bring about this change, but the reform can be effected in only one way. You must give to your universities the means of supporting fully and generously those men of genius who have shown themselves capable of extending the boundaries of human knowledge, and demand of them, *only*, that they devote their lives to study and research, and let me assure you that no money can be spent which will yield a larger or more valuable return.

If you do not look beyond your material interests, the higher life of the nation, which you will thus serve to cherish and foster, will guard your honor, and protect your home; and, on the other hand, what can you expect in a nation whose highest ideal is the dollar, or what the dollar will buy, but venality, corruption, and ultimate ruin?

But, rising at once to the noblest considerations, and regarding only the welfare of your country and the education of your race, what higher service can you render than by sustaining and cherishing the grandest thought, the purest ideals, and the loftiest aspirations, which humanity has reached, and making your universities the altars where the holy fire shall be kept ever burning bright and warm?

Do you think me an enthusiast? Look back through history, and see for yourselves what has made the nations great and glorious. Why is it that, after twenty centuries, the memory of ancient Greece is still enshrined among the most cherished traditions of our race? Is it not because Homer sang, Phidias wrought, and Plato, Aristotle, Demosthenes, Thucydides, with a host of others, thought and wrote? Or, if for you the military exploits of that classic age have the greater charm, do not forget that, were it not for Grecian literature, Thermopylæ, Marathon, and Salamis, would have been long since forgotten, and that the bravery, self-devotion, and patriotism, which these names embalm, were the direct fruits of that higher life which those great thinkers illustrated and sustained. And, coming down to

modern times, what are the shrines in our mother-country which we chiefly venerate, and to which the transatlantic pilgrim oftenest directs his steps? Is it her battle-field, her castles and baronial halls, or such spots as Stratford-on-Avon, Abbotsford, and Rydal Mount? Why, then, will we not learn the lesson which history so plainly teaches, and strive for those achievements in knowledge and mental culture which will be remembered with gratitude when all local distinctions and political differences shall have passed away and been forgotten?

While I was considering the line of discourse which I should follow on this occasion, an incident occurred suggesting an historical parallel, which will illustrate, better than any reflections of mine, the truth I would enforce. The ship Faraday arrived on our coast after laying over the bed of the Atlantic another of those electric nerves through which pulsate the thoughts of two continents, and, as I read the description of that noble ship, fitted out with all the appliances which modern science had created to insure the successful accomplishment of the enterprise, I remembered that not a century had elapsed since the first obscure phenomena were observed, whose conscientious study, pursued with the unselfish spirit of the scientific investigator, had led to these momentous results, and my imagination carried me back to an autumn day of the year 1786, in the old city of Bologna, in Italy, and I seemed to assist at the memorable experiment which has associated the name of Aloysius Galvani with that mode of electrical energy which flashes through the wire-cords that now unite the four quarters of the globe.

Galvani is Professor of Anatomy in the University of Bologna, and there is hanging from the iron balcony of his house a small animal preparation, which is not an unfamiliar sight in Southern Europe, where it is regarded as a delicacy of the table. It is the hind-legs of a frog, from which the skin had been removed, and the great nerve of the back exposed. Six years before, his attention had been called to the fact that the muscles of the frog were convulsed by the indirect action of an electrical machine, under conditions which he had found very difficult to interpret. He had connected the phenomenon with a theory of his own: that electricity—that is, common friction-electricity, the only mode of electrical action then known—was the medium of all nervous action; and this had led him into a protracted investigation of the subject, during which he had varied the original experiment in a thousand ways, and he had now suspended the frog's legs to the iron balcony, in order to discover if atmospheric electricity would have any effect on the muscles of the animal.

Galvani has spent a long day in fruitless watching, when, while holding in his hand a brass wire, connected with the muscles of the frog, he rubs the end, apparently listlessly, against the iron railing, when, lo! the frog's legs are convulsed.

The patient waiting had been rewarded, for this observation was the beginning of a line of discovery which was ere long to revolutionize the world. But Galvani was not destined to follow far the new path he had thus opened. The remarkable fact observed was this: The convulsions of the frog's legs could be produced without the intervention of electricity, or, at least, of the one kind of electricity then known, and Galvani soon found out that the only condition necessary to produce the result was, that the nerve of the frog should be connected with the muscle of the leg by some good electrical conductor. But, although Galvani followed up this observation with the greatest zeal, and showed remarkable sagacity throughout his whole investigation, yet he was too strongly wedded to his own theory to interpret correctly the facts he observed. He supposed, to the end of his life, that the whole effect was caused by animal electricity flowing through the conductor from the nerve to the muscle, and his experiments were chiefly interesting to himself and to his contemporaries, from the light they were supposed to throw on the mysterious principle of life. We now know that animal electricity played only a small part in the phenomena he observed, and that the chief effects were due to a cause of which he was wholly ignorant.

Galvani published his observations in 1791, in a monograph entitled "The Action of Electricity in Muscular Motion." This publication excited the most marked attention, and, within a year, all Europe was experimenting on frogs' legs. The phenomena were everywhere reproduced, but Galvani's explanation of the phenomena was by no means so universally accepted. His theory was controverted in many quarters, and by no one more successfully than by Alexander Volta, Professor of Physics in the neighboring University of Pavia. Volta, while admitting, with Galvani, that the muscular contractions were caused by electricity, explained the origin of the electricity in a wholly different way. According to Volta, the electricity originated not in the animal, but in the contact of the dissimilar metals, or other materials used in the experiment. This difference of opinion led to one of the most remarkable controversies in the history of science, and for six years, until his death in 1798, Galvani was occupied in defending his theory of animal electricity against the assaults of his distinguished countryman.

This discussion created the liveliest interest throughout Europe. Every scholar of science took sides with one or the other of these eminent Italian philosophers, and the scientific world became divided into the school of Galvani and the school of Volta. Yet, so far at least as the fundamental experiment was concerned, both were wrong. The electricity came neither from the body of the frog nor from the contact of dissimilar kinds of matter, but was the result of chemical action, which both had equally overlooked. But, nevertheless, the controversy led to the most important results: for Volta, while en-

deavoring to sustain his false theory by experimental proofs, was led to the discovery of the *voltaic* pile, or, as we now call it, the *voltaic* battery, an instrument whose influence on civilization can be compared only with the printing-press and the steam-engine. Yet, although the whole action of the battery was in direct contradiction to his pet theory, still, to the last, Volta persistently defended the erroneous doctrine he had espoused in his controversy with Galvani thirty years before, and he died in 1827, without realizing how great a boon he had been instrumental in conferring on mankind; so true it is, that Providence works out her bright designs even through the blindness and mistakes of man.

But there is another lesson to be learned from this history, which cannot be too often rehearsed in this self-sufficient age, which boasts so proudly of its practical wisdom. There were, doubtless, many practical men in that city of Bologna to smile at their sage professor who had spent ten long years in studying, to little apparent purpose, the twitchings of frogs' hind-legs, and there was many a jest among the courtiers of Europe at the expense of the learned philosophers who "wasted" so much time in discussing the cause of such trivial phenomena. But how is it now?

Less than a century has passed since Galvani's death; and, in a small hut, on the shores of Valentia Bay, may be seen one of the most skillful of a new class of *practical men*, representing a profession which owes its origin to Galvani and Volta. This *electrician* is watching a spot of light on the scale of an instrument which is called a *galvanometer*. Since the fathers fell asleep, the field of knowledge which they first entered has spread out wider and wider before the untiring explorers who have succeeded them. Oersted and Seebeck, Arago and Ampère, Faraday and our own Henry, have made wonderful discoveries in that field; and other great men, like Steinheil, Wheatstone, Morse, and Thomson, have invented ingenious instruments and appliances, by which these discoveries might be made to yield great practical results.

The spot of light, which the electrician is watching, is reflected from one of the latest of these inventions—the reflecting galvanometer of Thomson. He and his assistants had been watching by turns the same spot for several days, since the Great Eastern had steamed from the bay, paying out a cable of insulated wire. These electricians had no anxiety as to the result, for daily signals had been exchanged between the ship and the shore, as hundreds after hundreds of miles of this electrical conductor had been laid on the bed of the broad ocean. The coast of Newfoundland had already been reached, and they were only waiting for the landing of the cable at the now far-distant end.

At length the light quivers, and the spot begins to move! It answers to concerted signals! And soon the operator spells out the

joyful message. The ocean has been spanned with an electric nerve, and the New World responds to the greetings of the Old.

Here is something practical, which all can appreciate, and all are ready to honor. We honor the courage which conceived, the skill which executed, and, above all, the success which crowned the undertaking. But, do we not forget that professor of Bologna with his frogs' legs, who sowed the seed from which all this has sprung? He labored without hope of temporal reward, stimulated by the pure love of truth; and the grain which he planted has brought forth this abundant harvest. Do we not forget, also, that succession of equally noble men, Volta, and Oersted, and Faraday, with many other not less devoted investigators of electrical science, without whose unselfish labors the great result never could have been achieved? Such men, of course, need no recognition at our hands, and I ask the question not for their sakes, but for ours. The intellectual elevation of the lives they led was their all-sufficient reward.

It is, however, of the utmost importance for us, citizens of a country with almost unlimited resources, that we should recognize what are the real springs of true national greatness and enduring influence. In this age of material interests, the hand is too ready to say to the head, "I have no need of thee," and, amid the ephemeral applause which follows the realization of some triumph over matter, we are apt to be deceived, and not observe whence the power came. We associate the great invention with some man of affairs who overcame the last material obstacle, and who, although worthy of all praise, probably added very little to the total wealth of knowledge, of which the invention was an immediate consequence; and, not seeing the antecedents, we are apt to underrate the part which the student or scientific investigator may have contributed to the result.

It is idle, for example, to speak of the electric telegraph as invented by any single man. It was a growth of time; and many of the men who contributed to win this great victory of mind over space "builded far better than they knew." As I view the subject, that invention is as much a gift of Providence as if the details had been supernaturally revealed. But, whatever may be our speculative views, it is of the utmost importance to the welfare of our community that we should realize the fact that purely theoretical scientific study, pursued for truth's sake, is the essential prerequisite for such inventions. *Knowledge is the condition of invention.* The old Latin word *invenio* signifies *to meet with*, or *to find*, and these great gifts of God are *met with* along the pathway of civilization; but the throng of the world passes them unnoticed, for only those can recognize the treasure whose minds have been stored with the knowledge which the scholar has discovered and made known.

If, then, as no one will deny, science and scholarship are the powers by which improvements in the useful arts are made, I might appeal

to your self-interest to support and cherish them. But I should despise myself for appealing to such a motive, and you for requiring it. The supreme importance of science and scholarship to a nation does not depend in the least on the circumstance that important practical results may follow. When, as in the case of Galvani's frogs, they come in the order of Providence, let us thank God for them as a gift which we had no right either to expect or demand. Science, if studied successfully, must be studied for the pure love of truth; and, if we serve her solely for mercenary ends, her truths, the only gold she offers, will turn to dross in our hands, and we shall degrade ourselves in proportion as we dishonor her. Galvani, and Volta, and Oersted, who discovered the truths of which the electric telegraph is a simple application, sure to be made as soon as the time was ripe, are not the less to be honored because they died before the fullness of that time had come. We honor them for the truths they discovered, and the lustre of their consecrated lives could be neither enhanced nor impaired by subsequent events; and it is because I am persuaded that such lives are the salt of the world, the saviors of society, that I would lead you to cherish and sustain them; and, that I may enforce this conclusion, allow me to ask your attention to another historical incident, which presents a striking parallelism to the last.

I must take you back to a period which we, of a nation born but yesterday, regard as distant, but which was one of the most noted epochs of modern history—the age of Luther and the Reformation. I must ask you to accompany me to the small town of Allenstein, near Frauenberg, in Eastern Prussia, where, on the 23d of May, 1543, there lay dying one of the great benefactors of mankind. This man, old at seventy years, "bent and furrowed with labor, but in whose eye the fire of genius was still glowing," was then known as one of the most learned men of his time. Doctor of Medicine as well as of Theology, Canon of Frauenberg, Honorary Professor of Bologna and Rome, while devoting his leisure to study, he had passed a life of active benevolence in administering to the bodily as well as the spiritual wants of the ignorant people among whom his lot had been cast. He was also a great mechanical genius, and, by various labor-saving machines, of his own invention, he had contributed greatly to the welfare of the surrounding country; but the superstitious peasants, although they had hitherto reverenced the great man as their best friend and benefactor, had been recently incited by his enemies and rivals in the Church to curse him as a heretic and a wizard. A few days back he had been the unwilling witness of one of those out-of-door spectacles, so common at that time, in which his scientific opinions had been travestied, his charities ridiculed, and his devoted life made the object of slander and reproach. This ingratitude of his flock had broken his heart, and he could not recover from the blow.

The occasion of this outburst of fanaticism was the approaching publication of a work in which he had dared to question the received opinions of theologians and schoolmen, in regard to cosmogony. He had, forsooth, denied that the visible firmament was a solid azure-colored shell, to which the sun and planets were fastened, and through whose opened doors the rain descended. He had proved that the sun was the centre of the system, around which the earth and planets revolved, and, with his clear scientific vision, he had been able to gain glimpses, at least, of the grand conceptions of modern astronomy: For this man was Nicolas Copernicus, and the expected book was his great work—"De Orbium Cœlestium Revolutionibus"—destined to form the broad basis of astronomical science. The work was printing at Nuremberg, and the last proofs had been returned; but reports had come that a similar outburst of fanaticism was raging at that place, that a mob had burnt the manuscript on the public square, and had threatened to break the press should the printing proceed. But, thanks to God! the old man was not to die before the hour of triumph came. While still conscious, a horse, covered with foam, gallops to the door of his humble dwelling, and an armed messenger enters the chamber, who, breathless with haste, places in the hands of the dying man a volume still wet from the press. He has only strength to return a smile of recognition, and murmur the last words:

"Nunc dimittis servum tuum, Domine."

Grand close of a noble life! The seed has been sown—what could we desire more?

Again the centuries roll on—not one, but three; while the seed grows to a great tree, which overshadows the nations. Great minds have never been wanting to cherish and prune it, like Tycho Brahe and Kepler, Galileo and Newton, Laplace and Lagrange; and although at times some, while lingering in the deep shade of the foliage, may have lost sight of the summit, the noble tree has ever pointed upward to direct aspiration and encourage hope.

On the evening of the 24th of September, 1846, in the Observatory of Berlin, a trained astronomical observer was carefully measuring the position of a faint star in the constellation Capricorn. Only the day before, he had received from Le Verrier a letter announcing the result of that remarkable investigation which has made the name of this distinguished French astronomer so justly celebrated. By the studies of the great men who succeeded Copernicus, his system had become so perfected as to enable the astronomer to predict, with unerring certainty, the paths of the planets through the heavens. But there was one failing case.

The planet Uranus, then supposed to be the outer planet of the solar system, wandered from the path which theory assigned to it; and although the deviations were but small, yet any discrepancy be-

tween theory and observation in so accurate a science as astronomy could not be overlooked. Long before this, the hypothesis had been advanced that the deviations were caused by the attractive force of an unseen and still more distant planet; but, as no such planet had been discovered, the hypothesis had remained until now wholly barren. The hypothesis, however, was reasonable, and furnished the only conceivable explanation of the facts; and, moreover, if true, the received system of astronomy ought to be able to assign the position and magnitude of the disturbing body, the magnitude and direction of the displacements being given.

This possibility was generally appreciated by astronomers, and the very great length and difficulty of the mathematical calculation which the investigation involved was probably the reason that no one had hitherto undertaken it. Le Verrier, however, had both the courage and the youthful strength required for the work. And now the great work had been done; and, on the 18th of September, Le Verrier had sent to the Observatory of Berlin his communication announcing the final result, namely, that the planet would be found about 5° to the east of the star Delta of Capricorn.

The letter containing this announcement was received by Galle, at Berlin, on the 23d, and it was Galle whom we left measuring the position of that faint star on the evening of the 24th. It so happened that a chart of that portion of the heavens had recently been prepared by the Berlin Observatory, and was on the eve of publication; and, on the very evening he received the letter, Galle had found, near the position assigned by Le Verrier, a faint star, which was not marked on this chart. The object differed in appearance from the surrounding stars, but still it was perfectly possible that it might be a fixed star which had escaped previous observation.

But, if a fixed star, its position in the constellation would not vary, while, if a planet, a single night would show a perceptible change of place. Hence, you may conceive of the interest with which Galle was measuring anew its position on the evening of the 24th.

The star had moved, and in the direction which theory indicated; and for once, at least, the world rang with applause at a brilliant scientific conquest, from which there was not one cent of money to be made. Yet, was that conquest any the less important to the world? What had it secured? It had confirmed the theory of astronomy which Copernicus and his successors had built up, and it had clinched the last nail in the proof that those grand conceptions of modern astronomy, now household thoughts, are realities, and not dreams. Certainly no military conquest can compare with this.

Do you smile at the enthusiasm which rates so high a purely intellectual achievement? Go out with me under the heavens, in some starlit night, and, looking up into the depths of space, recall the truths you have learned in regard to that immensity, and allow the imagina-

tion free scope as it stretches out into the infinitudes of time, space, and power, carrying the mind on, bound by bound, through the limitless expanse, until even the imagination refuses to follow, and fairly quails before the mighty form of the Infinite, which rises to confront it! Remember now that your forefathers, of only a few centuries back, saw there nothing but a solid dome hemming in the earth and skies, and that you are able to look upon this grand spectacle only because great minds have lived who have opened your intellectual eyes; and then answer me, is not this result worth all the labor, all the sacrifice, all the treasure, it has cost?

Every educated man, who has not sold his birthright for a mess of pottage, lives a grander and a nobler life, because the great astronomers have thought and taught, and this elevation of human life is the greatest achievement of which man can boast. Before it all material conquests appear of little worth, and the lustre of all military or civil glory grows dim. Cherish this intellectual life; foster it; sustain it; do what you can by your own spirit and influence, and, if you are blest with riches, give of your abundance to support and encourage those who, by genius, talent, and devotion, will widen the intellectual kingdom. Be assured you will thus help to confer an inestimable boon on your race and on your country; and the influence for good will not be felt by the *intellectual* life of the nation only; that corruption which is now festering at the heart of our body politic, and threatening its destruction, can in no way be fought and conquered so effectually as by keeping constantly before the nation noble and high ideals; for, where the higher life is cherished and honored, the mercenary and sensual motives of action, which both invite and shield corruption, lose much of their force and power.

But you may tell me that there is a life higher than the intellectual life, and that I have ascribed to science and scholarship influences which come only from a source which I have forgotten, or left out of view. My friends, all truth is one and inseparable, and I have therefore made no distinction in this address between the truths of science and the truths of religion. That grand old word knowledge, as I have used it, includes both, and in just the proportion that you reverence religion, you must reverence also true science. All truth is God's truth, and, in praying for the coming of his kingdom, you certainly do not expect that Nature will be divorced from Grace. If the truths of religion required a special revelation, it must be expected that they would transcend human intelligence. These very conditions imply conflict, but the conflict comes not from the knowledge, but from the ignorance and conceit of men; and the only proper attitude for the devout scholar is 'to labor and to wait.' And what more wonderful confirmation could we have of the essential unity of the two phases of truth than is to be found in the fact that the characteristic of science, which I have been endeavoring to illustrate in this

address, is the great prominent feature of Christianity. Christianity was revealed in a life, and ever abides a life in the soul of man, to purify, ennoble, and redeem humanity.

"And so the Word had breath, and wrought,
With human hands, the creed of creeds,
In loveliness of perfect deeds,
More strong than all poetic thought—

"Which he may read that binds the sheaf,
Or builds the house, or digs the grave,
And those wild eyes that watch the wave,
In roarings round the coral-reef."

SKETCH OF DR. J. L. LE CONTE.

THIS gentleman was elected, at the Portland meeting, last year, President of the American Association for the Advancement of Science for 1874, and will preside at the twenty-third session, to be held at Hartford, Conn., commencing August 12th. He belongs to a family that has made itself distinguished in American science, mainly in the direction of natural history and geology, his own chosen field of inquiry having been chiefly that of entomology.

JOHN L. LE CONTE was born in New York, on May 13, 1825. His father, Major John Eatton Le Conte, formerly of the U. S. Army, possessed broad culture both in science and literature, and was well known among the early botanists and zoologists of the country.

The family is descended from a Huguenot of noble birth, who emigrated to New York in consequence of the religious and political persecutions which followed the revocation of the Edict of Nantes. Major Le Conte and his brother Louis were close students and accurate observers, almost from the beginning of the century, though the extreme diffidence of the latter, added to the want of proper channels for publication, prevented him from contributing to the literature of science. Two of the sons of Louis Le Conte, John and Joseph, formerly of Georgia and South Carolina, but now of the University of California, have made many valuable additions to physics and geology.

The subject of the present sketch was inspired, at an early age, by the example and teaching of his father, with a strong passion for science. After an academic course at Mt. St. Mary's College in Maryland, where he graduated in 1842, he studied medicine at the College of Physicians and Surgeons, in New York, receiving his diploma in 1846. The intervals between the courses, and other times later in life, were

occupied in extensive journeys in the United States, for the purpose of making collections in natural history, upon one branch of which, the *Coleoptera* of North America, he gradually concentrated his attention, while still retaining his interest and endeavoring, by books, to keep up his knowledge of collateral subjects.

In 1852 Major Le Conte and his son removed from New York to Philadelphia, which, on account of the greater activity in science then existing, was believed by them to offer, by its libraries, collections, and personal associations, better facilities for study.

The survey of the Interoceanic-Railway route across Honduras, by Mr. J. C. Trautwine, gave Dr. Le Conte an opportunity of spending a few months in the tropics in 1857; and a short memoir, on the economic geology of the State, from his pen, is contained in the final report of the survey, printed in London. Another, on the famous "Fuente de Sangre," will be found in the appendix to the second work of Hon. E. G. Squier, on Central America, solving the mystery of that singular phenomenon.

During the late civil war he entered the army medical corps as surgeon of United States volunteers, and, on the occurrence of a vacancy, was promoted to the grade of Lieutenant-Colonel and Medical Inspector U. S. A., in which capacity he served until the mustering out of the inspectors after the close of the war, in 1865.

The cessation of official duties enabled him again to resume his scientific pursuits, the results of which continue to be published in scientific magazines and transactions of learned societies.

The survey for the extension of the Kansas Pacific Railway under General W. W. Wright, in 1867, enabled him to visit a portion of Colorado and New Mexico. Some new observations on the geological structure of the regions adjacent to the route surveyed will be found in the report which he then prepared.

His contributions to the study of North American *Coleoptera* are very numerous; for their titles, the "Bibliographia" of Dr. Hagen, and the annual reports on the progress of entomology, must be referred to. A compendium of the arrangement adopted by him may, however, be found in the classification of the *Coleoptera* of North America, Smithsonian "Miscellaneous Collection," 8vo.

As an evidence of the general appreciation of his memoirs, he has been elected honorary member of many foreign and domestic scientific societies, and correspondent of a still larger number.

CORRESPONDENCE.

CURIOUS ACTION OF MUCILAGE ON GLASS.

THE article on "The Action of Sunlight on Glass," published in THE POPULAR SCIENCE MONTHLY for May, has elicited from Dr. F. Hollick, of this city, inquiries concerning the large plate-glass window of 104 Broadway, which is very much disfigured. Dr. Hollick says: "A 'Notice' was written on a piece of common brown paper, and pasted on the inside of the window with ordinary mucilage. On removing this 'Notice,' it was observed that the mucilage did not come off clean. Water, alcohol, and various other solvents, were employed, but all to no purpose, the glass remaining dim wherever the mucilage had been applied; the fact was, as was evident on inspection, that the surface of the glass was corroded, as if it had been acted upon by fluoric acid; and, what is more singular still, this corrosion has been extending ever since, till it now covers a large space. There seems to be a process of disintegration, or molecular change going on, which bids fair to destroy, in time, the whole pane. Now, the question comes, What is the nature of this change, and how was it started? The paper was of the ordinary brown wrapping kind, and the mucilage such as is in common use, and which has no action upon the bottle which contains it."

In reply to this inquiry, Mr. Thomas Gaffield, of Boston, writes:

To the Editor of the Popular Science Monthly.

SIR: A few days ago I received from a gentleman in New York some pieces of a large pane of plate-glass, taken from a window on Broadway, upon which had been affixed, with common mucilage, a notice written upon brown paper. When this notice was removed in about forty-eight hours, it was found that the portion of the surface covered by the mucilage was roughened, and presented an appearance of little hollows, or pits, from which the glass had been actually torn away by the washing or tearing off of the brown paper.

My informant says that some workmen passing by noticed the injured glass, and went in to examine it, stating that they had removed two other panes for the same defect. At the same time, experiments on other glass with similar paper and mucilage had led to no similar results, showing that all glasses are not so affected. My correspondent is surprised at what he has noticed, and desires an explanation of the cause. I will give my humble suggestions on the matter, and let others with more scientific knowledge enjoy the same privilege.

Let me at first, however, give a brief account of a few similar but very rare occurrences; for, though my New York friend names a fact not often noticed in the books, yet it is another illustration of the old saying, that "there is nothing new under the sun."

While spending some time, in 1862, in looking over the "Transactions" of the English and French scientific associations for one or two past centuries, I found the following very interesting item in the "Histoire de l'Académie," for 1708, page 22:

"EXFOLIATED GLASS.

"A person having applied to a piece of glass, about six inches square, a paste of Spanish white and glue size, placed the whole in the sun, during the great heat of summer. The paste, which was turned toward the sun, having been heated, rolled itself up, so that, in its movement, its under side was raised upward. But, what was more singular, this surface raised with it, and carried away, a layer of the glass. This layer made on the paste a species of varnish, as of porcelain, the thickness not exceeding one-half a line. It was astonishing that the adherence of the paste to the glass was so strong; and equally so, that it should be able to detach from the glass so considerable a sheet. It had been blown, and apparently they had replunged the pipe, with which it was blown, in the crucible at different times, which had given it several layers, which, however, were not apparent, because they were exactly ap-

plied one upon another. It is to Geoffroy that we owe this observation."

This was the only item of the kind which I ever found in the old books, and I had my doubts of its accuracy, until I read, in the London *Photographic News* of July 17, 1868, the following article:

"CURIOUS EFFECT OF GELATINE UPON GLASS.

"A correspondent sends us the following account of a curious result:

"Having, for experimental purposes, poured a thick solution of gelatine upon a number of glass plates, three of them were set aside upon a shelf for some months; and one day, upon looking at them, I found that, in all three cases, the gelatine had separated from the glass, bringing away the whole surface of the glass plates in shivers, which firmly adhered to the gelatine. The surface of the glass was left full of ruts, like water-worn stones. I suppose it to be caused by the strong contraction of the gelatine, and its firm hold upon the glass."

I wrote a short notice of these two similar facts for the Philadelphia *Photographer*, of November, 1868.

Singularly enough, just after this date, while experimenting in making my "photographic self-prints from Nature" (an account of which I have sent you in my little pamphlet), I noticed a similar phenomenon.

You will recollect that I place leaves and ferns upon glass with mucilage, and print their forms upon sensitive paper by exposure to the sunlight. After the ferns are dried up, I clean the glass for further use. In washing one of these glasses, it was impossible to make the surface perfectly clean. On a close examination, I found that, in removing the ferns and mucilage, the latter had taken off a portion of the glass, so that I could distinctly observe, on the crowded surface, the outlines of an anchor (which was the figure produced), and the forms of some of the individual ferns. I have this curious specimen—not of plate, but of sheet glass—in my cabinet, and will show it to you or any of your correspondents who may call on me.

There are numerous very interesting thoughts and queries suggested by the various and yet similar incidents referred to above. In making sheet window-glass, the workman makes three, and, for very thick glass, four gatherings upon his blow-pipe, creating, as suggested, three or four layers in the finished pane of glass, although not visible to the naked eye. Some workmen reheat the glass after the last gathering, in order, by what is called "burning over," to make the heated ball more uniform and homogeneous. The glass is then more easily and perfectly annealed, and more easily and safely cut by the diamond. The sheet-glass, named in the curious incidents related above, was probably of a kind not "burnt over" and perfectly homogeneous, and, for this reason, more easily disintegrated by the strong adhesive and contracting power of the gelatine and mucilage, overcoming the cohesion of the atoms and layers of the glass.

While crown and sheet glass have an original fine surface, that of plate-glass is softer and more easily affected, because it is an artificial one, which has been subjected to the three successive operations of the grinding, smoothing, and polishing machines.

The above explanation supposes mechanical action only. But, it is possible, a chemical action took place also, especially in the plate-glass, in the formation of some acid, by the fermentation of the gelatine or mucilage, when under the influence of sunlight or the atmosphere. The glasses all contained alkali, in the form of soda or potash, and perhaps some uncombined alkali, which might have formed a chemical combination with the acid of the mucilage, and so corroded or disintegrated the surface of the glass. The effect observed was, undoubtedly, the result of both mechanical and chemical action.

I found, on inquiry of several dealers in chemicals, that mucilage frequently contains acetic acid or alum, to prevent the formation of mould. In such cases, the acetic acid might easily form a chemical attachment, under the warming influence of the sun's rays, for some of the constituents of the glass, creating acetate of soda, of potash, or of iron.

Alum (which is a compound of sulphate of alumina and sulphate of potash), under the same influence, might be subject

to the chemical interchange called isomorphism, giving up its potash for some of the soda in the glass. These new compounds, if soluble in water, would be removed in washing off the mucilage, or, if insoluble, would be torn away when pulling off the paper attached by the adhesive gum.

In view of these facts, it would be well not to run the risk of possible injury to any of our valuable windows by affixing notices upon them with mucilage.

My correspondent thinks he noticed a continued or increasing corrosion, or disintegration, of the surface of the plate-glass after the removal of the mucilage. On examination of one of the pieces sent to me, I found a discoloration, occasioned by what we call "rust," in a part not affected by the mucilage, and this was probably what our friend observed.

There are glasses sometimes made with an excess of uncombined alkali which effloresces upon the surface, sometimes before it is placed in the window, and sometimes at a later period. This, of course, causes a series of infinitesimal holes or furrows in the glass, whose surface by the reflection and refraction of the rays of light presents, like the mother-of-pearl, all the colors of the rainbow when held in a certain position, and at the right angle for such effect. This is one kind of what is called stained or rusty glass. In other specimens the disintegration goes beyond the infinitesimal character and is plainly visible, making the glass appear as if fire-cracked, and in its ultimate effect producing the appearance, on one or both surfaces, of ground glass.

In one of these stages of rust or disintegration I find a piece of the glass referred to by my correspondent.

In reference to the matter of rust on glass, for the comfort of my readers and of my New York friends who are dealers in window-glass (which was my business for many years), let me say that this difficulty or defect is not an every-day trouble, but only one of the incidents or curiosities of glass-making. A good glass-maker knows how to avoid it, and a good glass-dealer can, in many instances, remove the first appearance of rust or stain on plate or sheet glass by a skillful and nimble use of dilute hydrofluoric acid and rouge or oxide of iron.

Glass-making and glass-dealing have their troubles, and this of occasional rust on glass is one. But all other kinds of business have their trials, and they all have their points of interest and satisfaction. In the study necessary to remove troubles and avoid mistakes, comes half the pleasure of life. If we had no obstacle in the path of our business, we ourselves would rust out.

In closing my article, let me add that I give my opinions only as humble suggestions, after such examination as I have been able to give to the subjects referred to.

In the light of new experiments, and the progress of scientific research by those who make it the business of life, the theories of to-day may be set aside by the revelations of to-morrow. If "an undevout astronomer is mad," so must be an undevout chemist, or student in any domain of natural science, who will not humbly bow before the wise and wonderful workings of the Great Maker of the universe. We cannot fully understand or explain them now. We can only look "through a glass darkly." We can see and enjoy the light of the sun, but, though great and learned volumes be written, who can fully explain all the laws and all the wonders of light, one of the gentlest and most ethereal, and yet one of the most interesting and powerful elements of the universe? We must be content to labor and to wait.

BOSTON, *July* 20, 1874.

EDITOR'S TABLE.

THE DUST OF THE UNIVERSE.

THE comet has come and gone, and again raised the perplexing question as to what such bodies are made of, and what are the most subtile forms of matter diffused through the celestial spaces. Of the great moving masses which compose our own system, from the sun—1,000,000 times larger than the earth—to the little asteroids—250 miles in diameter—and from these down to the meteorites

of a few pounds in weight, which strike the earth, we have become quite familiar, while spectrum analysis has carried us a long way toward the conclusion that there is a unity in the material composition of the universe. But, as every thing is in motion, and all the celestial masses are revolving and whirling at great rates of speed, and, as there is much evidence of fractures, collisions, and transformations, it seems impossible that there should not have been going on constant abrasions and comminutions, with the production of all grades of dust down to the most impalpable, as a consequence of the general wear and tear. Such a notion would, of course, have been inadmissible in old times, when people reasoned about the universe from their *a priori* notions of what it ought to be; and, holding that the heavens are the type of all perfection, they would have been shocked at the notion that the gearing of the spheres could not work without the production of dirt and dust. But we have survived those prejudices, and now search for the celestial *débris* and waste with just as much interest as we do for more imposing and dignified objects.

It is but a few years since the world was surprised and delighted by that brilliant series of researches made by Prof. Tyndall, on the formation of artificial clouds and artificial sky by the electric light, in his vacuum-tubes. Spaces, washed clean, and apparently pure, were found to be filthy with dust, and, beginning with the thinnest transparent vapors, he was able to develop a succession of the most exquisite cloud-forms definitely related to the colors of the spectrum as the molecules grew in complexity under the chemical transformation. The firmamental blue he found to be caused by impurities in the air, so attenuated as to react only with the finest waves of the ethereal medium. How far down in the scale of minuteness beyond all previous conception the particles are, which reflect the azure light of the sky, may be gathered from the following memorable passage, taken from Dr. Tyndall's "Fragments of Science" (page 148):

"From their perviousness to stellar light and other considerations, Sir John Herschel drew some startling conclusions regarding the density and weight of comets. You know that these extraordinary and mysterious bodies sometimes throw out tails 100,000,000 of miles in length, and 50,000 miles in diameter. The diameter of our earth is 8,000 miles. Both it and the sky, and a good portion of space beyond the sky, would certainly be included in a sphere 10,000 miles across. Let us fill a hollow sphere of this diameter with cometary matter, and make it our unit of measure. To produce a comet's tail of the size just mentioned, about three hundred thousand such measures would have to be emptied into space. Now, suppose the whole of this stuff to be swept together and suitably compressed, what do you suppose its volume would be? Sir John Herschel would probably tell you that the whole mass might be carted away at a single effort by one of your dray-horses. In fact, I do not know that he would require more than a small fraction of a horse-power to remove the cometary dust. After this you will hardly regard as monstrous a notion I have sometimes entertained concerning the quantity of matter in our sky. Suppose a shell to surround the earth at a height above the surface which would place it beyond the grosser matter that hangs in the lower regions of the air—say at the height of the Matterhorn or Mont Blanc. Outside this shell we have the deep-blue firmament. Let the atmospheric space beyond the shell be swept clean, and let the sky-matter be properly gathered up. What is its probable amount? I have sometimes thought that a lady's portmanteau would contain it all. I have thought that even a gentleman's portmanteau—possibly his snuff-box—might take it in. And, whether the actual sky be capable of this amount of condensation or not, I entertain no doubt that a sky quite as vast as ours, and as good in appearance, could be formed from a quantity of matter which might be held in the hollow of the hand."

Whatever may be the validity of these quantitative speculations, all the lines of investigation seem to converge

to the conclusion that there is such a thing as a cosmical dust, and that this form of matter, subtile as it may be, is by no means without effect in the operations of the universal scheme. The inconceivably rapid growth of the tails of comets directed away from the sun, and the mighty sweep of their movements, seem inconsistent with the direct flight or passage of cometary particles, and the effect is now rather explained on the hypothesis that matter already existing, diffused through space, may become in some way electrically polarized and rendered luminous through the mutual action of the sun and the comet. A recent writer suggests that "these polarized particles, or molecules of vapor, require time to become depolarized and to lose their luminosity, which fact may at least in part account for the breadth of the illuminated space or the apparent spread of the tail." The earth is believed to have passed through a portion of the tail of the comet of 1861. On the 30th of June its distance from the earth was rather less than 13,000,000 miles, and its train was computed to be 20,000,000 miles in length. The positions were such that it is quite possible that, on the evening of June 30th, the earth might have been involved in the tail, while certain unusual phenomena of an electrical nature were actually observed at that time. The writer on "Comets," in Brande's "Cyclopedia," says:

"It is a remarkable and significant fact that, not only in various parts of England and Ireland, but also in Spain, Italy, Switzerland, and other Continental countries, a very peculiar phosphorescence, or illumination of the sky, was perceptible during the early hours of the night in question, which many persons supposed to be caused by the aurora borealis, unusual as the phenomenon is in the summer months, especially in the south of Europe; at the same time it was remarked that the luminosity of the sky did not resemble the usual effect of the aurora, but was something quite exceptional. We incline to attribute the phenomenon to the presence of cometic matter (if matter it can be termed) in our atmosphere."

A new set of researches has recently been made known in *Poggendorf's Annalen* for March, of the present year, which seem to have a further bearing upon the problem of a universal dust. Prof. A. C. Nordenskiöld, of Stockholm, has instituted a series of investigations into the nature of the fine matter entangled and brought to the earth in great snow-storms. After one of these great storms, which occurred on December 1, 1871, he melted a quantity of the newly-fallen snow to ascertain whether it contained any solid particles. A cubic metre was thus tested, and found to contain minute traces of metallic iron and of carbon. He made a second experiment in Finland, in the midst of a large forest, and again particles of carbon and metallic iron were found. Desirous of extending his observations to widely-separated tracts, in 1872 he several times collected snow at localities north of the island of Spitzbergen with the same result—analysis showing the presence of iron, nickel, and cobalt. This dust from the snow greatly resembled a powder previously discovered by him on some islands thirty miles distant from the coast of Greenland, and was probably identical with it. The latter he has called *Krykonit*, and he was able to collect large quantities of it, and to prove that it contains *organic matter*, in addition to its other ingredients. It seems highly probable, if not indeed quite certain, that this dust, collected in the snow, is of cosmical origin, and is to be ranked with meteoric matter.

THE OXYGEN CENTENNIAL.

THIS event went off with great success and satisfaction, according to arrangement, July 31st and August 1st, at Northumberland, Pa., where the great discoverer spent his last days. There

was an excellent representation of American chemists from all parts of the country, the exercises were spirited and appropriate, and the entire proceedings vindicated the excellent judgment of the committee who had made the arrangements.

The sessions were held in the new high-school building, and its large hall was crowded with strangers and citizens. Prof. Croft read a brief address on the character of PRIESTLEY, which was marked by a broad appreciation of his strong and many-sided traits. The subject, however, was much too large for the time given to it, and the sketch had the effect of awakening more interest than it gratified. The speaker apologized for his performance on account of the short time that had been allowed him to prepare it, and it is to be hoped that he will be enabled to give it greater fullness before publication in the volume which will embody the proceedings.

Prof. Horsford read several manuscript letters of Dr. Priestley belonging to the Massachusetts Historical Society, and not hitherto published. They were written in this country, to a friend, and are valuable as disclosing his opinions concerning questions of American politics, in which he took no public part. They were written with terseness, point, and vigor, and displayed an independence of spirit and an acuteness of observation and reflection that elicited the cordial applause of the audience who listened to them. Prof. Croft had alluded to a rumor, on the authority of the French chemist, Dumas, that Priestley died of poison; but he had been unable to find any verification or explanation of it. One of the letters read by Prof. Horsford threw light upon the matter, as Dr. Priestley wrote to his friend that the ingredient found in the flour used by the family turned out to be, not arsenic, but tartar-emetic.

Prof. Sterry Hunt gave an interesting address on the progress of theoretical chemistry since the time of Priestley, in which, after an acute and instructive analysis of the influence of Lavoisier in giving effect to Priestley's discovery and laying the foundation of modern chemical philosophy, he went on to trace the successive modifications of theory, the growth of the unitary system, and the fundamental ideas of the chemical science now generally received. Prof. Hunt's statement was deficient, in that it did not recognize the share that the speaker had himself taken in promoting the new views, but, aside from this, it was a remarkably clear and instructive presentation, in a narrow compass, of a subject not easy of popular exposition.

Dr. J. Lawrence Smith read a valuable essay on the general progress of chemistry as applied to the arts during the last hundred years, which was full of interesting information, and was listened to with close attention by a large audience. The relation of the industries of the world to the work of the laboratory was skillfully treated and vividly delineated.

In the cemetery of Northumberland, situated upon an eminence back of the town, and commanding a most beautiful view of the river and mountain scenery, rest the remains of Priestley, marked only by a simple tombstone. The strangers present in town, accompanied by many of the citizens, visited the grave at the close of the first day's proceedings, and there listened to an eloquent and appreciative eulogy of the illustrious man by President Coppee, of Lehigh University.

The public exercises were fitly concluded, on August 1st, by a most interesting address from Prof. Silliman, on the progress of chemistry in this country since the time of Priestley. The son of one of the eminent pioneers of the science on this side of the Atlantic, Prof. Silliman has been a student of the subject from his boyhood, there being,

perhaps, no American more familiar with its history, or better qualified to present it. He labored under the difficulty of all the speakers, that his subject was too extensive to be treated in the time at command, and we hope that this difficulty will be amply repaired when his essay is printed, for a good history of the growth of American chemistry is much needed. The effect of the centennial contributions to the historic literature of the subject cannot fail to be favorable to the increasing cultivation of the science, both in its theoretical and practical aspects.

A feature of the occasion of peculiar interest was the collection of various memorials of Dr. Priestley, conveniently arranged in a large room for general inspection. There were many vestiges of the apparatus he used in his chemical investigations, and of his microscopical and electrical instruments. There were also copies of his numerous works in various languages, and several portraits and engravings, illustrative of the events and circumstances of his life. These relics were of great interest, and were examined with much curiosity by those who had made the pilgrimage to the scene of his closing labors.

The house which Dr. Priestley built, and in which he died, was also visited, and found to be in a good state of preservation. It is an ample wooden structure, plain, but thoroughly finished. Attached to it on one side was his laboratory—a large apartment, with a chimney in one corner for the escape of chemical exhalations. The situation of the dwelling was once fine, the spacious grounds sloping down to the Susquehanna, and being covered with trees. But there is now a canal in front, and a railroad at the back-door, which render it ineligible for a residence; and the pilgrims were informed, by a conspicuous sign, that it was "for sale." It seems there has been a rumor that the house was haunted, but this was strenuously denied on the part of those who were interested in disposing of it.

The descendants of Dr. Priestley, to the sixth generation, are to be found in Northumberland, and, as we might naturally expect, the family has been prominent in the history of the town. Dr. Joseph Priestley, a leading physician of the place, and his brother, Marks B. Priestley, great-grandsons of the old doctor, are prominent citizens, and their doors were thrown open with a cordial hospitality to the strangers who had come together to honor their illustrious ancestor. Other citizens, moreover, gave a kindly and generous welcome to the visitors, and did all in their power to make the occasion as pleasant as it must ever be memorable to all who participated in it.

RECENT PROGRESS IN THE HIGHER EDUCATION.

It cannot be otherwise than gratifying to all the friends of improvement in the higher culture of the country to have noted the recent indications of a rapidly deepening popular interest in the subject. That an intelligent public such as ours should entertain a profound concern for its common schools, and strive incessantly for their amendment, is nothing more than might be expected; but, that vast multitudes of people should be stirred with intense solicitude about the result of the latest reform in collegiate education is no less remarkable than encouraging. It has been reproachfully said that people brought up under a popular form of government, with equal rights, claims, and privileges, will become so steeped in democratic sentiment as to have little care for that high and thorough training which but a small and select portion of the community can attain, and for which it is the main office of universities to provide. But we have now before us indubitable proof that crowds of people of all sorts and grades

may be agitated to the utmost depths and carried away in enthusiasm over the workings of our collegiate system. At the late competitive examination, held at Saratoga, to decide upon the relative attainment in a new branch of scholarship, nine of the leading colleges of the country entered the lists, and the concourse of people that gathered to witness the exercises and note the result was something altogether unprecedented among educational exhibitions on this side of the Atlantic. It can no longer be said that learning and its devotees are unappreciated by our people. They came from all parts of the country through the sweltering heat, were thickly stowed away in suffocating bedrooms, relished the stale mutton and wilted cucumbers furnished by the landlords, and trailed day after day through miles of grime and smudge to reach the place of inter-collegiate trial, and went wild with tumultuous excitement when one group of students exhibited greater proficiency than the rest. It was a great event for the higher education of this land, and will no doubt result in many new accessions to the college classes, and in raising still higher the standard of attainment in the new direction of study.

LITERARY NOTICES.

LOGIC, INDUCTIVE AND DEDUCTIVE. By ALEXANDER BAIN, LL.D., Professor of Logic in the University of Aberdeen. New and Revised Edition. 731 pages. Price, $2.00. D. Appleton & Co.

FROM Aristotle, the father of the science, to the present day, logic has been one of the leading elements of a liberal education. During the middle ages it was understood and practised as the art of reasoning; with the rise of modern science, it has been systematically extended so as to embrace the laws or principles to which the mind conforms in the search for truth. Dependent upon the larger science of mental philosophy or psychology, it has been constantly affected by the progress that has taken place in the knowledge of mind. The most influential modern work upon this subject is that of Mr. Mill, who was incited to undertake it by the perusal of Dr. Whewell's "History of the Inductive Sciences." His Logic was undoubtedly Mill's great work, and will occupy a prominent place in the history of the development of the science; but it aimed to be a constructive and epoch-making treatise, and was designed for the use of scholars rather than for general students.

Mr. Bain was the life-long and intimate friend of Mr. Mill, and was intrusted by the latter with the supervision of the proofs of the first edition of his work on logic for the press. He is, besides, one of the leading psychologists of the age, and author of a system of mental philosophy, which stands high as an original contribution to the advancement of the subject. He has been Professor of Logic in the University of Aberdeen for many years, and was thoroughly qualified to prepare a valuable book upon the subject. But, whereas Mill addressed himself to philosophers, and occupied himself with abstruse and original inquiries, Mr. Bain has taken for his task to treat the subject in a more popular manner, adapted to all classes of students. His volume may be regarded as, in fact, a popular treatise from the most modern point of view; and so well has he succeeded with this feature of the work, that persons entirely unfamiliar with the subject may read it with interest and profit.

And yet nothing would be more unjust to Prof. Bain than the idea that his work is in any sense a compilation. It is, on the contrary, a treatise of marked originality, and has been developed entirely from the author's point of view as an independent student. One of the most instructive and interesting parts of the volume is book fifth, treating of the "Logic of the Sciences," or, what may be called, logic in its concrete and practical applications. "The Logic of Mathematics," "The Logic of Physics," of Chemistry, of Biology, of Psychology, of Politics, of Medicine, and what the author calls "The Logic of Practice," are considered in separate chapters, and, in connection with the "Classification of the Sciences," they form a most valuable state-

ment of the fundamental ideas and the peculiar conditions of reasoning in all these important branches of knowledge. Although the work is comprehensive and a perfect treasury of information upon the subject, yet Dr. Bain points out in the preface how it may be used as an elementary book, while its extremely low price is favorable to its general introduction into schools.

ANCIENT FAITHS EMBODIED IN ANCIENT NAMES; or, an Attempt to trace the Religious Belief, Sacred Rites, and Holy Emblems of Certain Nations, by an Interpretation of the Names given to Children by Priestly Authority, or assumed by Prophets, Kings, and Hierarchs. By THOMAS INMAN, M. D. (London). 2 vols. 8vo, pages 792 and 1028. Price, $27.00. Second Edition. New York: Asa K. Butts & Co., 36 Dey Street, 1874.

THIS is, undoubtedly, a work of vast research, and implying, in the author, an intimate acquaintance with the languages and literatures of antiquity. We have, here, an immense amount of curious knowledge with regard to the sacred rites of ancient religions. The emblems, symbols, or images, which have served as representatives of Deity, and which have received worship from man, are shown to be much the same the world over. The author very elaborately develops the precise meaning of the principal emblems used to represent the Supreme Being, and one of the most interesting features of his book is the learning with which these are traced through the Assyrian, Hebrew, Syrian, and other religions, and even the Christian religion itself, in some of its forms. The central idea of the work, if it has any central idea, is not indicated by the title. Judging from that, the reader would expect to find a list of names of persons analyzed, and, from the elements of these names, the religious beliefs and practices of those who gave or wore them inferred: that is to say, the work would be mainly philological. This, however, is not the case; the work is rather historical. The subjects are treated in alphabetical order, and this, by-the-way, is the only sign of order we find in the work: the same topics are treated over and over again, even unto weariness and disgust. Special prominence is given to the discussion of the relations of sex to the problem of religious emblems, a question which has latterly much engaged the attention of archæologists. From the following very brief list of subjects, our readers will, perhaps, be able to see the scope of the work: Anthropomorphism, Ark, Canon of Scripture, Chrisna, Cross, Demon, Hell, JAH, Infidelity, Inspiration, Mary, Miracles, Oracles, Phallus, Prayer, Prophecy, Religion, Sabbath, Sacti, Sun-worship, Theology, Trinity, Urim and Thummim. Though many extraneous matters are brought into this work, which, it would seem, ought to have been discussed elsewhere, the reader will hardly be disposed to complain, for all that the author writes is worthy of consideration, even if out of place. The text is fully and elegantly illustrated with woodcuts and plates.

HEALTH AND EDUCATION. By the Rev. CHARLES KINGSLEY, F. L. S., F. G. S., Canon of Westminster. New York: D. Appleton & Co., 549 & 551 Broadway. Pages 411. Price, $2.00.

THIS is a unique volume from the vigorous and brilliant pen of the versatile Canon of Westminster, novelist, essayist, naturalist, professor of history, and preacher, and so strong in each as to have won a commanding place in the literature of the time. Mr. Kingsley has here given us the result of his long observations and reflections on the theory, philosophy, and practical conduct of life. His work is popular in the highest sense; that is, it is not only designed for general influence, but it is done in its author's best style of literary art, and is vivid, quaint, pungent, and impressive. It is well known that Canon Kingsley is one of the masters of the English language, and it is fortunate when he brings his unusual powers of presentation to bear upon familiar and important subjects of daily life. For the difficulty with people generally is, not that they are ignorant, or have not had truth enough explained to them, but that it is so vaguely conceived and so feebly held that it does not take hold of the feelings and coerce the conduct. For this reason, much of the tame didactic statement of current science is to a great degree powerless for good. It is

here that the forcible, pointed, and picturesque writer is of invaluable service, and it is here that Canon Kingsley excels. The contents of the volume are varied and suggestive, and it abounds in passages of pointed common-sense, like the following fresh plea for the practical study of botany by girls, as grounds of important mental discipline:

"Mothers complain to me that girls are apt to be—not intentionally untruthful—but exaggerative, prejudiced, incorrect, in repeating a conversation or describing an event; and that from this fault arise, as is to be expected, misunderstandings, quarrels, rumors, slanders, scandals, and what not.

"Now, for this waste of words there is but one cure: and if I be told that it is a natural fault of women; that they cannot take the calm, judicial view of matters which men boast, and often boast most wrongly, that they can take; that under the influence of hope, fear, delicate antipathy, honest moral indignation, they will let their eyes and ears be governed by their feelings; and see and hear only what they wish to see and hear: I answer, that it is not for me as a man to start such a theory; but that, if it be true, it is an additional argument for some education which will correct this supposed natural defect. And I say deliberately that there is but one sort of education which will correct it; one which will teach young women to observe facts accurately, judge them calmly, and describe them carefully, without adding or distorting: and that is, some training in natural science.

"I beg you not to be startled: but if you are, then test the truth of my theory by playing to-night at the game called 'Russian Scandal;' in which a story, repeated in secret by one player to the other, comes out at the end of the game, owing to the inaccurate and—forgive me if I say it—uneducated brains through which it has passed, utterly unlike its original; not only ludicrously maimed and distorted, but often with the most fantastic additions of events, details, names, dates, places, which each player will aver that he received from the player before him. I am afraid that too much of the average gossip of every city, town, and village is little more than a game of 'Russian Scandal;' with this difference, that, while one is but a game, the other is but too mischievous earnest.

"But now, if among your party there should be an average lawyer, medical man, or man of science, you will find that he, and perhaps he alone, will be able to retail accurately the story which had been told him. And why? Simply because his mind has been trained to deal with facts; to ascertain exactly what he does see or hear, and to imprint its leading features strongly and clearly on his memory.

"Now, you certainly cannot make young ladies barristers or attorneys; nor employ their brains in getting up cases, civil or criminal; and as for chemistry, they and their parents may have a reasonable antipathy to smells, blackened fingers, and occasional explosions and poisonings. But you may make them something of botanists, zoologists, geologists.

"I could say much on this point: allow me at least to say this: I verily believe that any young lady who would employ some of her leisure time in collecting wild-flowers, carefully examining them, verifying them, and arranging them; or who would in her summer trip to the sea-coast do the same by the common objects of the shore, instead of wasting her holiday, as one sees hundreds doing, in lounging on benches on the esplanade, reading worthless novels, and criticising dresses—that such a young lady, I say, would not only open her own mind to a world of wonder, beauty, and wisdom, which, if it did not make her a more reverent and pious soul, she cannot be the woman which I take for granted she is; but would save herself from the habit—I had almost said the necessity—of gossip: because she would have things to think of and not merely persons; facts instead of fancies; while she would acquire something of accuracy, of patience, of methodical observation and judgment, which would stand her in good stead in the events of daily life, and increase her power of bridling her tongue and her imagination. 'God is in heaven, and thou upon earth; therefore let thy words be few;' is the lesson which those are learning all day long who study the works of God with reverent accuracy, lest by misrepresenting them they should be tempted to say that God has done that which he has

not; and in that wholesome discipline I long that women as well as men should share."

In his lecture on the Tree of Knowledge, Mr. Kingsley has the following observations on the causes of intemperance:

"It is said by some that drunkenness is on the increase in this island. I have no trusty proof of it: but I can believe it possible; for every cause of drunkenness seems on the increase. Overwork of body and mind; circumstances which depress health; temptation to drink, and drink again, at every corner of the streets; and finally, money, and ever more money, in the hands of uneducated people, who have not the desire, and too often not the means, of spending it in any save the lowest pleasures. These, it seems to me, are the true causes of drunkenness, increasing or not. And if we wish to become a more temperate nation, we must lessen them, if we cannot eradicate them.

"First, overwork. We all live too fast, and work too hard. 'All things are full of labor, man cannot utter it.' In the heavy struggle for existence which goes on all around us, each man is tasked more and more—if he be really worth buying and using—to the utmost of his powers all day long. The weak have to compete on equal terms with the strong; and crave, in consequence, for artificial strength. How we shall stop that I know not, while every man is 'making haste to be rich, and piercing himself through with many sorrows, and falling into foolish and hurtful lusts, which drown men in destruction and perdition.'

"But it seems to me also, that in such a state of society, when—as it was once well put—'every one has stopped running about like rats:'—that those who work hard, whether with muscle or with brain, would not be surrounded, as now, with every circumstance which tempts toward drink; by every circumstance which depresses the vital energies, and leaves them an easy prey to pestilence itself; by bad light, bad air, bad food, bad water, bad smells, bad occupations, which weaken the muscles, cramp the chest, disorder the digestion. Let any rational man, fresh from the country—in which I presume God, having made it, meant all men, more or less, to live—go through the back streets of any city, or through whole districts of the 'black countries' of England; and then ask himself—Is it the will of God that his human children should live and toil in such dens, such deserts, such dark places of the earth? Let him ask himself—Can they live and toil there without contracting a probably diseased habit of body; without contracting a certainly dull, weary, sordid habit of mind, which craves for any pleasure, however brutal, to escape from its own stupidity and emptiness? When I run through, by rail, certain parts of the iron-producing country—streets of furnaces, collieries, slag-heaps, mud, slop, brick house-rows, smoke, dirt—and that is all; and when I am told, whether truly or falsely, that the main thing which the well-paid and well-fed men of those abominable wastes care for is—good fighting-dogs: I can only answer, that I am not surprised.

"I say—as I have said elsewhere, and shall do my best to say again—that the craving for drink and narcotics, especially that engendered in our great cities, is not a disease, but a symptom of disease; of a far deeper disease than any which drunkenness can produce; namely, of the growing degeneracy of a population striving in vain by stimulants and narcotics to fight against those slow poisons with which our greedy barbarism, miscalled civilization, has surrounded them from the cradle to the grave. I may be answered that the old German, Angle, Dane, drank heavily. I know it: but why did they drink, save that for the same reason that the fenman drank, and his wife took opium, at least till the fens were drained? why but to keep off the depressing effects of the malaria of swamps and new clearings, which told on them—who always settled on the lowest grounds—in the shape of fever and ague? Here it may be answered again, that stimulants have been, during the memory of man, the destruction of the Red Indian race in America. I reply boldly, that I do not believe it. There is evidence enough in Jacques Cartier's 'Voyages to the Rivers of Canada;' and evidence more than enough in Strachey's 'Travaile in Virginia'—to quote only two authorities out of many—to prove that the Red Indians, when the white man first met with them, were, in North and South alike, a dis-

eased, decaying, and, as all their traditions confess, decreasing race. Such a race would naturally crave for 'the water of life,' the 'usquebaugh,' or whiskey, as we have contracted the old name now. But I should have thought that the white man, by introducing among these poor creatures iron, fire-arms, blankets, and, above all, horses wherewith to follow the buffalo-herds which they could never follow on foot, must have done ten times more toward keeping them alive, than he has done toward destroying them by giving them the chance of a week's drunkenness twice a year, when they came in to his forts to sell the skins which, without his gifts, they would never have got.

"Such a race would, of course, if wanting vitality, crave for stimulants. But if the stimulants, and not the original want of vitality, combined with morals utterly detestable, and worthy only of the gallows—and here I know what I say, and dare not tell what I know, from eye-witnesses—have been the cause of the Red Indians' extinction: then how is it, let me ask, that the Irishman and the Scotsman have, often to their great harm, been drinking as much whiskey—and usually very bad whiskey—not merely twice a year, but as often as they could get it, during the whole 'iron age;' and, for aught any one can tell, during the 'bronze age,' and the 'stone age' before that: and yet are still the most healthy, able, valiant, and prolific races in Europe? Had they drunk less whiskey they would, doubtless, have been more healthy, able, valiant, and perhaps even more prolific, than they are now. They show no sign, however, as yet, of going the way of the Red Indian.

"But if the craving for stimulants and narcotics is a token of deficient vitality; then the deadliest foe of that craving, and all its miserable results, is surely the Sanitary Reformer; the man who preaches, and—as far as ignorance and vested interests will allow him—procures, for the masses, pure air, pure sunlight, pure water, pure dwelling-houses, pure food. Not merely every fresh drinking-fountain: but every fresh public bath and wash-house, every fresh open space, every fresh growing tree, every fresh open window, every fresh flower in that window—each of these is so much, as the old Persians would have said, conquered for Ormuzd, the god of light and life, out of the dominion of Ahriman, the king of darkness and of death; so much taken from the causes of drunkenness and disease, and added to the causes of sobriety and health.

"Meanwhile one thing is clear: that if this present barbarism and anarchy of covetousness, miscalled modern civilization, were tamed and drilled into something more like the kingdom of God on earth: then we should not see the reckless and needless multiplication of liquor-shops, which disgraces this country now. . . .

"I said just now that a probable cause of increasing drunkenness was the increasing material prosperity of thousands who knew no recreation beyond low animal pleasure. If I am right—and I believe that I am right—I must urge on those who wish drunkenness to decrease, the necessity of providing more, and more refined, recreation for the people.

"Men drink, and women too, remember, not merely to supply exhaustion; not merely to drive away care; but often simply to drive away dullness. They have nothing to do save to think over what they have done in the day, or what they expect to do tomorrow; and they escape from that dreary round of business thought, in liquor or narcotics. There are still those, by no means of the hand-working class, but absorbed all day by business, who drink heavily at night in their own comfortable homes, simply to recreate their overburdened minds. Such cases, doubtless, are far less common than they were fifty years ago: but why? Is not the decrease of drinking among the richer classes certainly due to the increased refinement and variety of their tastes and occupations? In cultivating the æsthetic side of man's nature; in engaging him with the beautiful, the pure, the wonderful, the truly natural; with painting, poetry, music, horticulture, physical science—in all this lies recreation, in the true and literal sense of that word, namely, the recreating and mending of the exhausted mind and feelings, such as no rational man will now neglect, either for himself, his children, or his workpeople."

CATALOGUE OF THE SOUTH MISSOURI STATE NORMAL SCHOOL, WARRENSBURG, JAMES JOHONNOT, Principal. Jefferson City: Regan & Carter.

OF all the forms of ephemeral literature, school catalogues are generally the most volatile, fleeting, and thoroughly worthless. The luxurious typography is, no doubt, pleasant to the pupils whose names are in the list, and, indicating the prosperity of the establishment, is a highly-dignified method of advertising. The deep philosophy of education that is propounded, and the high-sounding promises of what is to be done next year, dressed in imposing rhetoric, are agreeable to read, but unsafe to trust, as they usually have a very loose relation with the facts.

The catalogue before us, however, is of quite exceptional character, and has interested us not a little. It is the result of a serious and earnest effort to carry out advanced ideas, and to place popular education more completely upon the basis of scientific principles than has hitherto been deemed practicable. In his eight pages of preliminary explanation of the course of study, Prof. Johonnot has given us a brief and excellent exposition of the underlying ideas of the new education, and has given ample and cogent reasons why the sciences should have a leading place in our improved systems of mental cultivation. But no amount of theorizing can be sufficient here. What we want is an actual curriculum, and the practical results of its working. Scientific education cannot be constructed, it must grow; but that growth can only come from trial and experience, and, what we want, therefore, is judicious educational experimenters to develop the new culture and show what it is capable of. They have entered boldly upon this path at the Warrensburg Normal School, and with something like an adequate appreciation of the just claims of scientific studies. While it is regarded by many educators as a great step of reform to recognize science at all, and to concede one, two, or three hours a week to some branches of it, Prof. Johonnot makes it the prominent and fundamental thing in the establishment over which he presides. Of the several lines of study, science occupies the first place, and is a regular daily exercise in every term. "In each science a strictly objective presentation is first made, by which the pupil observes the objects and facts upon which the science is founded, and is led to make general classifications. Farther along in the course, each science is treated again upon a higher plane, leading to more minute investigations and to broader generalizations; and in several instances the subject recurs three times before it is finally dismissed." We may add that the scientific course is broad and comprehensive, and one of the features of the plan of teaching is the explanation of new discoveries and important results, as fast as they occur in the scientific world.

PUBLICATIONS RECEIVED.

Nomenclature of Diseases (Woodworth). Washington: Government Printing-Office. Pp. 232.

Exposures in Fire Insurance (Ross). New York: Appletons. Pp. 59.

National Educational Association. 1873. Pp. 272.

Physiology of the Circulation (Pettigrew). Macmillan. Pp. 337. Price, $4.00.

Catalogue of Wild Plants in New Jersey (Willis). New York: Schermerhorn. Pp. 92. Price, $1.00.

Elmwood Cemetery, Memphis. Pp. 222.

United States Mining Industry (Raymond). New York: Ford & Co. Pp. 555. Price, $4.50.

The Stevens Battery. Pp. 30.

Morgan Expeditions, 1870–'71. Pp. 60.

Reception of Dr. Gould at Boston. Pp. 32.

Report of the Curators of Missouri University (1874). Pp. 185.

Kindergarten Messenger (Monthly). Pp. 24.

Bulletin of Cornell University (Science). Vol. I. Nos. 1 and 2. Pp. 63.

The Rapid Writer (Monthly). Andover, Mass. Pp. 16.

Bench and Bar Review (Quarterly). Baltimore: A. Schaumburg. Pp. 200. Per annum, $5.00.

Kentucky State Medical Association. 1874. Pp. 262.

Experiments, showing Character and Position of Neutral Axes (Nickerson, C. E.). Pp. 26.

"Do Snakes swallow their Young?" (Goode). Pp. 12.

The Analyst, Monthly Journal of Pure and Applied Mathematics. Des Moines, Iowa. Pp. 20.

Mechanical Properties of Materials of Construction (Thurston). Pp. 28.

Assaying by the Spectroscope (Du Bois). Pp. 12.

The Mystery of Life (Cox). Pp. 32.

The Plagopterinæ and the Ichthyology of Utah (Cope). Pp. 14.

Transmission of Diseases (Hamlin). Pp. 9.

Papers chiefly Anatomical (Wilder). Pp. 94.

Transformations of the House-Fly (Packard). Pp. 14.

Geographical Variation of North American Birds (Allen). Pp. 10.

Mammals of Kansas, etc. (Allen). Pp. 23.

Statistical Atlas of the United States. Part III. Vital Statistics.

Darwinism and Language (Whitney). Pp. 30.

MISCELLANY.

Coggia's Comet.—The comet which lately made such a grand display in our northern heavens was discovered by Coggia, at Marseilles, on April 17th. When first seen, the nucleus and coma together had a diameter of 100,000 miles, the comet being then 133,000,000 miles from the earth, and 153,000,000 from the sun. It travels round the sun in the same direction as the planets, but in an orbit the plane of which is very much inclined. Of all the planetary orbits, excepting those of the asteroids, that of Mercury is most oblique, having a slant of seven degrees; but the inclination of the orbit of Coggia's Comet is nearly ten times as great, being set down at 66°. Its perihelion passage, or nearest approach to the sun, occurred on July 8th, when it came within 62,000,000 miles of that orb, and it was then moving at the rate of 160,000 miles an hour. It continued to approach the earth until July 20th, coming, on that date, within 26,000,000 miles of us, when it appeared at its brightest, or, according to Prof. Parkhurst, 140 times more brilliant than when first discovered. Of its tail, the same authority says: "On June 25th the observed length of the tail was computed as 3,000,000 miles; on July 1st, 5,000,000 miles; on July 13th, 12,000,000 miles—an increase, after the first of that month, of one-twelfth per day. The tail continued, from its first appearance till the head of the comet ceased to be visible, to point from the latter directly toward the stars Beta and Gamma of the Lesser Bear. Afterward it moved slowly to the westward, so that it covered the dipper of the Greater Bear. The speed of the particles leaving the head to form the tail was estimated as over 3,000,000 miles per day. This brings the particles leaving the comet on July 4th to a distance from its head on July 24th of about 26,000,000 miles, corresponding at the latter date with the distance of the head of the comet from the earth. But, though the tail thus sweeps over sufficient space to cover the interval between the nucleus and the earth, the direction of the tail is such that it fails to reach us; its central line being distant about 4,000,000 miles, and the edge of the tail about 1,500,000 miles, from the earth."

Concerning the theory which accounts for the formation of comets' tails by a repulsive action of the sun on the matter of the nucleus, Prof. Parkhurst also writes, in the *Tribune* of July 23d: "The existence of a repelling force was suggested by the fact that a comet's tail, pointing eastward when the comet is east of the sun, points northward and westward as the comet itself moves around to the north and west of the sun. Yet, as there is no coherence in the tail, it is evident that no repelling force from the sun, when it is to the east of the sun, can have any tendency to bring it around to the west of the sun. The fact

is, that the tail which is to be seen to the west of the sun is composed of entirely different matter from that which was seen to the east. The former matter has been repelled so far from the sun, and has been so expanded, that it has become invisible; and new matter has been repelled from the nucleus, forming a new tail upon the western side. The law of repulsion will not only account for this, but for the formation of a new tail at the rate of 30,000,000 miles per day, as recorded in the case of the comets of 1680 and 1843. The magnitude of the comet's tail in those instances was stupendous; but its velocity was no less astounding. It commenced to move at the rate of 30,000,000 miles per day; but, unlike the motion of the comet itself, the motion is accelerated so long as the repelling force continues to operate. There is no retarding force, as in the motion of a receding comet. Whatever velocity has once been reached is retained, and the particles are constantly receiving an accelerating force from the time they leave the head of the comet, although the amount of the accelerating force which they receive will gradually diminish as the distance from the sun increases. There is no known instance of a comet coming into our system with a velocity approaching this; and, as the tail of a comet is chiefly formed after it has passed its perihelion, when each successive addition to the tail is impelled with less velocity than that which started before it, there seems to be no alternative to the theory that the matter forming a comet's tail is so thoroughly diffused in space that it can never be reunited."

Astronomers appear to be agreed that Coggia's Comet is an entire stranger to us, if not to these regions of space. It was at first surmised that it might be the one seen by the French missionaries in China in 1737, thus making its period of revolution 137 years. But the opinion of Prof. Hind, as lately expressed in *Nature*, is that, notwithstanding similarity of orbit, the two are not identical. The orbit of this latest comer has not been definitely determined, but is pronounced either a parabola or hyperbola. As the comet will be visible in the Southern Hemisphere until the end of September, more on this interesting point will probably be learned before its final disappearance.

Brain Development in the Mammalia.—According to the researches of Prof. Marsh, the larger mammals of the Tertiary period, as compared with their existing representatives, were sadly deficient in brains. Their later remains, however, afford evidence of steady improvement in this particular. The mammals of the Eocene all had small brains, being little better provided in this respect than the higher reptiles. The type genus of the largest of the Eocene mammalia, *Dinoceras*, nearly equaled the elephant in bulk, but had a brain only about one-eighth the size of that in existing rhinoceroses. The smallness of the cavity in the other genera of this order was equally remarkable. The Brontotherium of the American Miocene (a later division of the Tertiary), while equaling the dinoceras in size, had a decidedly larger brain-cavity; and, in the still later strata of the Pliocene, a species of mastodon was found which likewise exhibited increase of brain-dimensions, the cavity approaching but not equaling that of existing proboscidians." The Tapiroid ungulates of the Eocene had small brain-cavities, much smaller than their allies the Miocene *Rhinocerotidæ*. The Pliocene representatives of the latter group had well-developed brains, but proportionally smaller than living species. A similar progression in brain-capacity seems to be well marked in the equine mammals, especially from the Eocene *Orohippus*, through *Miohippus* and *Anchitherium* of the Miocene, *Pliohippus* and *Hipparion* of the Pliocene, to the recent *Equus*. In other groups of mammals, likewise, so far as observed, the size of the brain shows a corresponding increase in the successive subdivisions of the Tertiary. These facts have a very important bearing on the evolution of mammals, and open an interesting field for further investigation."

The Peabody Museum of Natural History.—We learn from the *College Courant* that the Peabody Museum of Natural History, connected with Yale College, is to be commenced at once. The building, when complete, will be 350 feet in length. At present, only one wing is to be built, cost-

ing $160,000, with a ground-plan of 115 feet by 100. It will be of brick, with cut-stone trimmings, and strictly fire-proof; of three stories, with high basement, making, virtually, four stories. This basement will be largely devoted to the exhibition of fossil footprints. The first story will be devoted to a lecture-room and a mineralogical cabinet; the second to geology, with the fossil vertebrates from the Rocky Mountains; the third to zoology, and the attic to archæology and ethnology. The funds for the erection and maintenance of this institution were furnished, in 1866, by the late George Peabody, who, by deed of gift dated October 22d of that year, gave $150,000 to Profs. J. D. Dana, O. C. Marsh, B. Silliman, G. J. Brush, and three others, in trust "to found and maintain a Museum of Natural History, especially of the departments of zoology, geology, and mineralogy, in connection with Yale College." The present curators of the several departments of the Museum are Prof. Brush, of the mineralogical, Prof. Marsh, of the geological, and Prof. A. E. Verrill, of the zoological department.

The Movement of Storms.—The *American Journal of Science* for July contains Part I. of an able paper, by Prof. Loomis, entitled "Results derived from an Examination of the United States Weather Maps for 1872 and 1873," read before the National Academy of Sciences in April last. The weather-maps which furnished the data for his examination exhibit storm-paths for 314 days. These he has carefully tabulated and classified. The course and velocity of the storms for each month are given, showing that the average velocity in forward movement was 26.6 miles per hour, that the greatest average velocity in any month was in February, it being 31 miles per hour; the lowest was in August, when the rate was 17.7 miles an hour. It also appears that their forward movement is greater in winter than in summer. But some atoms move with exceptional velocity. Thus, in May 15, 1873, a storm-centre advanced 1,200 miles in twenty-four hours, while, in other cases, there was no forward movement, and the storm-centre remained stationary for twenty-four hours. The average direction of the storm-paths for two years was 8° north of east; in summer, nearly due east; in winter, more northward; but most northward in fall and spring. In October the direction was 21° north of east. Instances occurred, however, in which storms moved north-northwest; and, on the 6th of April, 1873, a storm in the Mississippi Valley moved in every direction in a little more than twenty-four hours.

Prof. Loomis carefully studied the causes which appear to influence the velocity and direction of storms. Of these, rainfall is important. It is found that the area of rainfall extends farther on the eastern than it does on the western side of a storm-centre; so that the rain-area is a long oval, the longer diameter of which is in or nearly in the direction in which the storm is moving. This is true of most of the storms which traverse the United States. This rain-area extends to an unusual distance on the eastern side of a storm when it is advancing—the average extent being about 500 miles.

By the condensation of vapor eastward of the storm, it, in a measure, makes its own way. Thus the barometer continually falls in advance of it, announcing its approach, but rises as the storm-centre is past. The conditions by which a storm is sustained, and which are present before or in front of it, cease to exist in its wake. Instances occur, however, in which increased velocity and condensation in the western quadrant of a storm set back the storm's centre, and give it, for a time, a retrograde motion. The wind on the western quarter of a storm usually blows with greater velocity by about 22 per cent. than it does on its eastern quadrant, and this is a means by which the forward motion is retarded; and it is found that, when the wind's velocity in the western quadrant is 44 per cent. greater than in the eastern, the storm's forward motion is seven miles an hour less than its average rate of progress.

The atmosphere in the storm circuit moves inward, but also upward, to the central region of the storm, which is supposed to be from one to two miles above the earth's surface. At this elevation atmospheric movements are greatly increased in velocity. Thus, at the summit of Mount Washington, the velocity was 29 miles an

hour, or, compared with that at the level of the sea, was as 5.5 to 1. By comparing the velocity of the wind at this elevation in the direction which the storm advances with the velocity of the storm's advance, Prof. Loomis is enabled to deduce a measure of the force of the upward movement of the centre of a storm.

Storms are divided, by Prof. Loomis, into two classes. Those of the first class traverse the continent northward of the fortieth parallel; many from the remote west reach the great lakes Superior and Huron, and show a decided preference for that region. Some of these have their origin among the Rocky Mountains, and some come from the mountains of Oregon. Those of the second class originate chiefly westward of the mouth of the Mississippi, and move nearly northeast. These comprise only about one-sixth of the whole number, but include some of the violent cyclones which traverse our coast.

NOTES.

CORRECTION. — In the article on the "Development of Psychology," in the August number, page 417, a long passage is represented as quoted. The *quotation* is an error of the printer.

THE National (British) Association for the Promotion of Social Science will assemble at Glasgow, September 30th, and will be in session till October 7th. President, the Earl of Roseberry. The presidents of departments are: Jurisprudence and Amendment of the Law, Lord Moncrieff; Repression of Crime, Frederick Hill; Education, Lords Napier and Ettrick; Health, Lyon Playfair; Economy and Trade, Sir George Campbell.

AT the summer distribution of prizes at University College, London, the first and second places, in the mixed class of jurisprudence, were both held by ladies—Miss E. Orme, who, two years ago, took the prize in political economy, coming out first; while, in the mixed class of political economy, this year, a lady took the fourth certificate.

MR. LICK'S first gift to the California Academy of Sciences was a piece of land, worth $250,000. By his recent deed, he provides the means for the erection of a suitable building for the Academy, to cost about $250,000. This is not all. The institution is provided by the generosity of Mr. Lick with ample funds to purchase books, collections, etc., and to carry on the Academy on a firm basis. The sum of the gifts thus made to this one institution amounts to over one million dollars.

IT is reported that the *Phylloxera vastatrix*, the worst of grape-vine pests, has made its way into Australia.

ANOTHER mountain of iron-ore has been discovered in Missouri. A shaft has been sunk on Shepherd Mountain, which has passed already through 70 feet of almost solid ore, and the quality of the deposit is improving as the shaft goes down. Shepherd Mountain is about six miles south of the famous "Iron Mountain."

A DISPATCH from Denver, Col., dated July 20th, states that the three topographical divisions of Prof. Hayden's Exploring Expedition had already taken the field, and Prof. Gardner's party was soon to follow. Dr. Hayden, with his selected party, will review the whole ground, viz., that part of Colorado south of the 40th parallel, and west of the Park Range. The expedition includes fifty persons.

THE large and valuable collection of natural history specimens procured by D'Albertis during his recent travels in New Guinea has been purchased by the Italian Government. D'Albertis intends soon to return to New Guinea to continue his researches.

A FEW drops of oil of bitter almonds on a little sawdust will serve as a good preservative of insects. Place the insects with the prepared sawdust in a hermetically-sealed flask. Insects have, in this way, been sent from Ceylon to France, and, when they reached their destination, were still so flexible as to permit of their being prepared and mounted, though they had been collected months previously.

THREE thousand acres of cotton have been planted in California this year, and the prospects are good for an abundant yield.

ALPHONSE DE CANDOLLE, the eminent botanist of Geneva, has been elected Foreign Associate of the French Academy of Sciences, as successor of the late Prof. Agassiz.

TWO scientific expeditions are to set out from Archangel next summer, one to explore the traces of ancient glaciers in Russian Lapland, and the other to pursue zoological investigations on the shore of the White Sea.

DR. DRUITT, an eminent physician and high authority on the subject of wine, says: "Civilized man must drink, will drink, and ought to drink; but it should be wine."

THE FOSSIL MAN OF MENTONE.